15th international Symposium on Materials in the Space Environment

13th international Conference on Protection of Materials and Structures from the Space Environment

Naturalis Biodiversity Center

European City of Science Leiden 2022

IMPORTANT INFORMATION AT A GLANCE

- Poster Room: on 7th floor in Naturalis
- Lunch (all days): Restaurant Naturalis
- Free access to museum area with conference badge
  No food and drinks allowed in the museum area
- Free WIFI throughout the whole conference area
  Network: Naturalis
  No password needed

Access to all abstracts via online programme:
Scan and access the programme directly

Visit us on Twitter @ismse15 for up to date information during the conference

Welcome Reception:
19 September 2022
18:30 - 21:00
on balcony in 7th floor in Naturalis

Conference Dinner:
21 September 2022, 19:00 - 23:00, in Louwman Museum
Buses arranged: 18:15 from Naturalis Parking area to venue / return: 22:45 from venue to Naturalis

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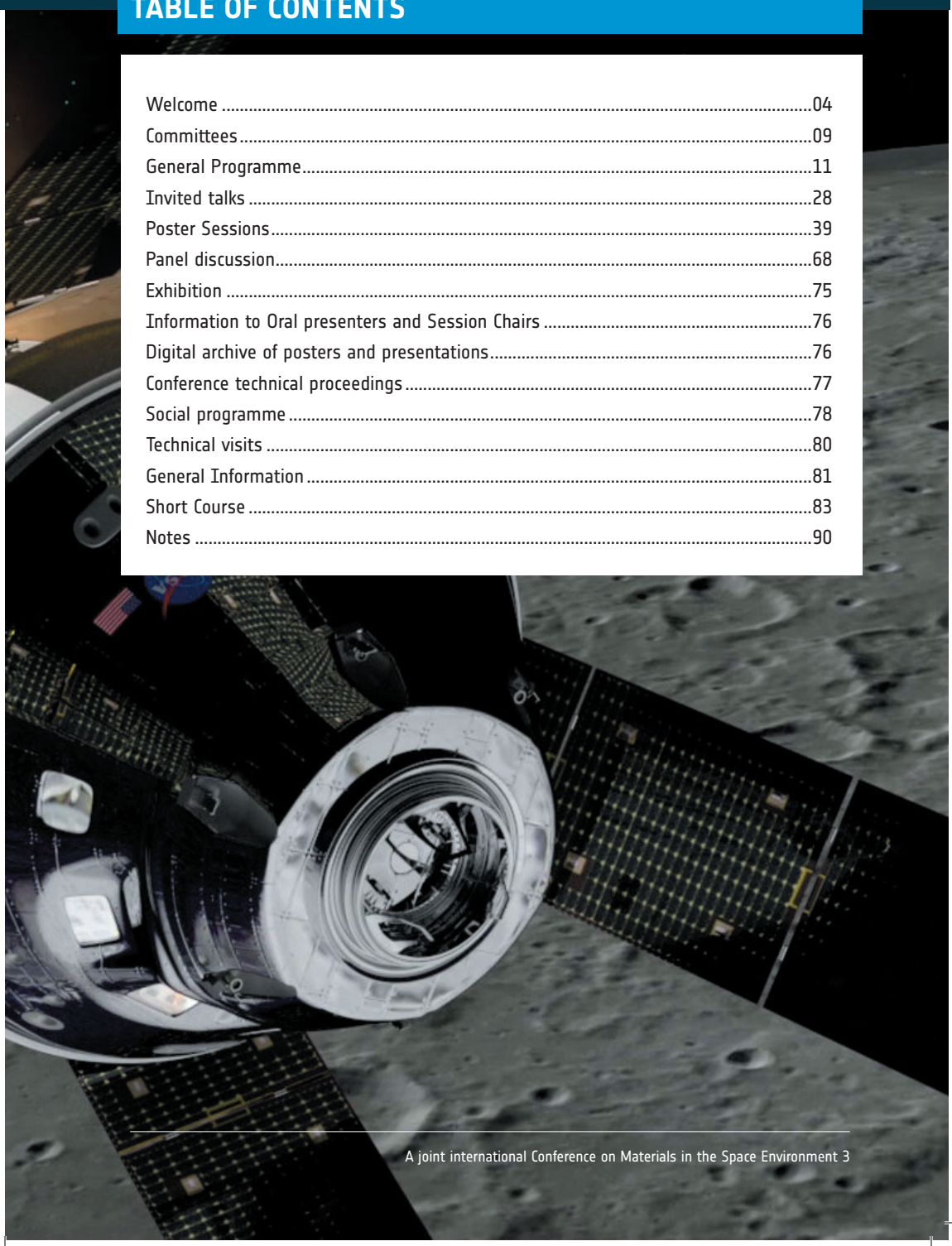

WELCOME TO ISMSE 15 / ICPMSE 13

It is our great pleasure to welcome you to this joint international conference on Materials in the Space Environment, organised this year by ESA and ITL together with our co-organisers CNES and ONERA. With a history of two conferences stretching back over 40 years, this year we bring together the 15th edition of the International Symposium on Materials in the Space Environment (ISMSE-15) and the 13th edition of the International Conference on Protection of Materials and Structures from the Space Environment (ICPMSE-13).

Since our last meeting in Biarritz in October 2018, we have all faced many challenges due to the COVID-19 pandemic, and we are therefore particularly pleased to be able to meet in-person again. We thank you for your patience, support and the extra efforts made to travel during this period. In fact, the present edition of the conference reaches records for the number of papers submitted and the registered participants, which is a clear sign of the continuing interest in research, development and industrial activities in the field of Materials in the Space Environment!

During the conference, we will address many of the emerging themes and international initiatives which are now driving the space business. Threats to global supply chains are currently severe, on the back of the COVID-19 pandemic, global conflict and the increasing impact of man-made environmental damage and climate change. We will address the short and long term impact on spacecraft materials procurement and review the efforts being made to develop suitable replacements for obsolete materials.

In the New Space era, commercial players are entering the market and providing cheaper routes to orbit, and new methodologies are being used to decrease hardware development time. As a consequence, the use of so-called commercial materials is becoming more widespread and we will look at what this means for mission reliability, longevity and space environmental survivability. Earth orbit is becoming cluttered and the space debris threat is increasing, whilst at the same time the use of very low earth orbits is increasing. We will have sessions which address clean space and sustainability, atomic oxygen and drag effects as well as a special session on the results from the Japanese SLATS experiment in Very Low Earth Orbit.

Moving out into the solar system, a key aim of all the major international players is to return to the Moon, to Mars and beyond. This interest is reflected in two new sessions and a discussion panel on the lunar environment and dust contamination, we well as a session on planetary environments. Of course, the traditional topics of the conference are not neglected and we have the usual sessions on cleanliness and contamination control, radiation degradation of materials, flight experiments, materials for harsh environments and standards and regulations. This reflects the continuing interest and the need for on-going research in these areas, as we strive to increase hardware performance and to push the limits of materials exposed to the space environment. We are also happy to see contributions on new manufacturing and testing methodologies based on concepts such as digitilisation, artificial intelligence, modelling and machine-based learning. We hope to see further expansion of these new topics for future editions of the conference.

The conference agenda includes a single plenary session throughout the week, introduced by invited talks, highlight lectures and a session on roadmaps for future technologies. This year we are also introducing an interactive round table discussion on the major themes of the conference, produced in collaboration with Smarter Shows. Please prepare your questions for the experts ! There will also be poster sessions, an exhibition, technical visits, and a short introductory course on the Sunday afternoon. Last but not least there will be some great social events and ample opportunities for networking and ad-hoc splinter discussions throughout the week. Let's maximise the benefits of being able to meet in-person again!

We hope you will enjoy your time at ISMSE-15 / ICPMSE-13 and we wish you a very successful conference.

ISMSE-15 and ICPMSE-13 programme and organising committees

WELCOME TO THE NATURALIS BIODIVERSITY CENTRE IN LEIDEN, EUROPEAN CITY OF SCIENCE 2022

For this year's conference, we have chosen the venue of the Naturalis biodiversity Centre in Leiden - awarded European museum of the year 2021. As well as its stunning architecture and convenient location, it also has strong scientific links and commitment to biodiversity and sustainability. It will be a good reminder about the sensitivity of our own environment on Earth and why we also need to focus on new materials, processes, regulations and industrial practices which will help the space industry to operate in a more sustainable manner.

A MESSAGE FROM NATURALIS

Naturalis is the national research institute for biodiversity. Our scientists dedicate themselves to describing, understanding and preserving biodiversity without interruption. At Naturalis, marvel is the starting point of learning. Together we discover the richness of nature. There is always more to be enthusiastic about, more to learn and more to explore. With a unique combination of knowledge, talents and skills, we operate as a national museum, academic research institute and heritage institution.

Naturalis' new museum is a combined experience of seeing and doing. All ages will experience the beauty and richness of nature in impressive galleries. In the new galleries you will learn everything about the earliest life on Earth, about The Netherlands in the Ice Age and about the immense forces of our planet. You will also discover the most surprising ways in which plants and animals seduce each other or look a huge African elephant right in the eyes. Ever wondererd about life in the Dinosaur Era? You no longer have to.

LOGISTICAL INFORMATION

Conference Venue Visiting address:

Naturalis Biodiversity Center
Darwinweg 2
2333 CR Leiden
The Netherlands

Transport

Travel by public transport is encouraged. There is a very efficient transport system in The Netherlands. Plan your bus or train journey here: https://9292.nl
There is limited car parking space available at Naturalis. A daily charge applies (administered by the museum, not the conference)

Registration / Welcome Desk Opening hours:

Monday 19th September 08:00-17:30
Tuesday 20th September 08:00-17:30
Wednesday 21st September 08:30-14:00
Thursday 22nd September 08:30-17:30
Friday 23rd September 08:30-13:00
For short course participants only, there will also be a chance to register on Sunday 18th September at ESA-ESTEC.

Lunches & Refreshments

Coffee and tea breaks and lunches will be served at the designated times as scheduled in the programme.
Lunches will be served in the Naturalis restaurant on the ground floor.

Language

The working language for the conference is English.

Wireless Internet

Internet access is available free of charge throughout the conference centre. The name of the Network is “Naturalis”. No password is needed.

Badges

Badges are required for admission to all Plenary, Oral and Poster sessions, and for visiting the museum. Please wear your badge visibly at all times.

Photography is prohibited

The use of cameras andor recording devices is strictly prohibited during the Plenary and all Oral sessions. In Exhibition and poster area, permission has to be granted by the Exhibitor or poster presenter. Personal photography is allowed at social events.

Distributing Commercial Material

Distribution of commercial material during sponsored events is permitted only to the event's sponsor.

PROGRAMME COMMITTEE

Mikko Nikulainen	ESA, The Netherlands	Chairperson
Sophie Duzellier	ONERA/DPHY, France	Co-Chairperson
Christian Durin	CNES, France	Co-Chairperson
Jacob Kleiman	ITL, Canada	Co-Chairperson
Adrian Tighe	ESA, The Netherlands	
Antonio Saverino	TAS-I, Italy	
Bohan Wu	BISEE, China	
Carlos Soares	NASAJPL, USA	
Christian Puig	Airbus, France	
Courtney Steagall	Jacobs Technology (NASA-JSC), USA	
Deborah Mueller	RUAG Zurich, Switzerland	
Irina Gouzman	Soreq, Israel	
Jean-François Roussel	ONERA, France	
Marianne Balat-Pichelin	PROMES, France	
Masahito Tagawa	Kobe University, Japan	
Riccardo Rampini	ESA, The Netherlands	
Stéphane Gendron	Canadian Space Agency, Canada	
Stephanie Remaury	CNES, France	
Tim Minton	University of Colarado, USA	
Yugo Kimoto	JAXA, Japan	
Kristiina Jokela	Aurora Propulsion Technologies, Finland	
Elisabeth Laurent	CNES, France	

ORGANISING COMMITTEE

Adrian Tighe	ESA
Bruno Bras	ESA
Christian Durin	CNES
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Jacob Kleiman	ITL
Kristien Bentley	ESA
Riccardo Rampini	ESA
Sarah Rodriguez	ESA
Sophie Duzellier	ONERA/DPHY
Anna Weithaler	ESA Conference Bureau

GENERAL PROGRAMME

A detailed programme with all abstracts (incl. posters) is available online at the conference website (https://atpi.eventsair.com/ismse15/programme).
Each abstract can be read online and downloaded on your device.
Follow the QR code below to go directly to the online programme.

PROGRAMME AT A GLANCE

Sunday 18th September	Monday 19th September	Tuesday 20th September
	08:00 Welcome desk open	08:00 Welcome desk open
	08:45 - 10:00 Opening Session Part 1	08:45 - 09:00 Overview of IOP proceedings
	10:30 - 11:00 BREAK inc. refreshments	09:00 - 10:30 Session 3 : Lunar Environment #1
	11:00 - 12:30 Opening Session Part 2	10:30 - 11:00 BREAK inc. refreshments
		11:00 - 12:30 Session 4 : Clean Space & sustainability
12.00 - 18:00 Short Course at ESA-ESTEC	12:30 - 14:00 LUNCH	12:30 - 14:00 LUNCH
	14:00 - 15:20 Session 1 : Contamination #1 (modelling)	14:00 - 15:30 Session 5 : Contamination #2 (monitoring)
	15:20 - 16:30 Company pitches inc. refreshments	15:30 - 17:00 POSTER SESSION #1 inc. refreshments
	16:30 - 18:00 Session 2 : LEO - VLEO	17:00- 18:00 Session 6 : Flight Experiments
	18:30 - 21:00 Welcome Reception at Naturalis	

Wednesday 21st September	Thursday 22nd September	Friday 23rd September
08:30 Welcome desk open	08:30 Welcome desk open	08:30 Welcome desk open
08:45 - 09:30 Christopher Semprimoschnig Memorial Lecture	08:45 - 09:30 Plenary Lecture "Reach for the stars! Space: the business and beyond“	09:00 - 09:50 Session 13A: Standards and Regulations
09:30 - 10:30 Session 7 : Radiation and Synergistic Effects	09:30 - 10:30 Session 9 : Lunar Environment #2	09:50 - 10:30 Session 13B: Long Term Storage
10:30 - 11:00 BREAK inc. refreshments	10:30 - 11:00 BREAK inc. refreshments	10:30 - 11:00 BREAK inc. refreshments
11:00 - 12:30 Session 8 : Innovative Materials and Processes	11:00 - 12:30 Session 10 : Focus on SLATS mission	11:00 - 12:10 Session 14: Planetary Environments
		12:10 : 13:00 Closing Session
12:30 - 14:00 LUNCH	12:30 - 14:00 LUNCH	13:00- 14:30 LUNCH
14:00- 14:45 Round Table 1	14:00 - 15:30 Session 11 : Contamination #3 (monitoring)	14:30 - 16:00 Technical site visits
15:00 - 15:45 Round Table 2	15:30 - 17:00 POSTER SESSION #2 inc. refreshments	
15:45 - 16:15 BREAK inc. refreshments	17:00- 18:00 Session 12 : Ground Facilities and Testing	
16:15 - 17:00 Round Table 3		
19:00 - 23:00 Conference dinner at Louwman Museum		

SUNDAY, SEPTEMBER 18TH, 2022

A short course will be given on the afternoon. See section on page 83

MONDAY, SEPTEMBER 19TH, 2022

08:00	Welcome desk opens
	Opening Session Part 1
08:45 - 09:00	Welcome from the organisers (ESA, CNES, ITL, ONERA)
09:00 - 09:20	Opening address from the ISMSE & ICPMSE programme committee chairs: Mikko Nikulainen (ESA) & Jacob Kleiman (ITL)
09:20 - 10:00	*The Triceratops Project: From Great Plains to exhibit hall*: Yasmin Grooters (Naturalis Biodiversity Center) - see abstract on page 28
10:00 - 10:30	*Advanced Concepts for Future Space Application: From Biomimetics to Advanced Materials:* Chris Broeckhoven and Derek Aranguren van Egmond (ESA) - see abstract on page 29
10:30 - 11:00	**Coffee Break AM - Day 1**
11:00 - 12:30	**Opening Session Part 2** Chaired by: Mikko Nikulainen (ESA) & Jacob Kleiman (ITL)
11:00 - 11:15	*S&MA activities of JAXA and future plans:* Shinichiro Ichimaru (JAXA, Japanese Space Agency) - see abstract on page 31
11:15 - 11:30	*Trends in European research on space materials*: Malgorzata Holynska (ESA, European Space Agency) - see abstract on page 32
11:30 - 11:45	*Perspectives on Canadian Space activities*

11:45 - 12:00	*Contamination Control and Materials Development Challenges for NASA Deep Space Missions*: Carlos Soares (NASA) - see abstract on page 3
12:00 - 12:15	*Spacecraft materials development and environmental effect evaluation in CAST*: Bohan Wu (Beijing Institute of Spacecraft Environment Engineering, BISEE) - by **WEBEX**
12:30 - 14:00	**Lunch - Day 1**
14:00 - 15:30	**Session 1: Contamination #1 Modelling** Chaired by: Carlos Soares (NASA-JPL) & Jean-François Roussel (ONERA)
14:00 - 14:20	*Development of Multispecies Model for Comprehensive Characterization of Outgassing Molecular Constituents:* John M. Alred & Carlos Soares & John Anderson (Jet Propulsion Laboratory, California Institute of Technology), Jean-François Roussel & David Lansade (ONERA/DPHY), Nishita Sinha (Harvard University, Department of Physics), Delphine Faye & Rioland Guillaume (CNES-CST)
14:20 - 14:40	*International Space Station Bipropellant Plume Contamination Model Update for Short Thruster Pulse Widths*: Katie Fox & Taria Usher & Alexandra Deal (The Boeing Company), Courtney Steagall (Jacobs Technology), Erica Worthy (NASA Johnson Space Center)
14:40 - 15:00	*Improvement of Bake-Out Prediction thanks to Realistic Species Separation:* Jean-François Roussel & David Lansade (ONERA/DPHY), Delphine Faye & Guillaume Rioland (CNES), Véronique Perrin & Sylvie Brosse & David Nguyen Van Sang (Thales Alenia Space), Christophe Théroude & Christopher Laurent (Airbus Defence and Space), Bayrem Zitouni (OHB System AG)
15:00 - 15:20	*Modelling of particulate contamination redistribution inside purged cavities*: Delphine Faye & Florent Dall'armi (CNES), Pierre Bombardier (FAURE QEI)

15:20 - 16:30	**Coffee Break PM - Day 1 - incl. Company Pitches**
16:30 - 18:00	**Session 2: Low and Very Low Earth Orbit (VLEO)** Chaired by: Timothy Minton (University of Colorado USA) & Masahito Tagawa (Kobe University Japan)
16:30 - 17:00	**Highlight Talk:** *Space Polymers Erosion in Simulated LEO and VLEO Environments*: Jacob Kleiman (Integrity Testing Laboratory Inc), Z. Iskanderova (AZ Smart Technologies), M. Tagawa & S. Nishioka & S. Horimoto (Kobe University)
17:00 - 17:20	*Interaction mechanisms between Atomic Oxygen and materials: investigation on reflected beam*: David Lévêque, Sophie Duzellier (ONERA), M. Vilaranda Fernandes & G. Chanteperdrix (AIRBUS DS), D. Nguyen Van Sang & V. Perrin-Bailly & P. Jouanne (Thales Alenia Space), E. Laurent (CNES)
17:20 - 17:40	*Diamond-Transition Metal Oxide Solid State Device as a Noval Real-Time Atomic Oxygen Flux Sensor*: Asaf Bolker & Nurit Atar & Ronen Verker & Irina Gouzman (Soreq NRC), Moshe Tordjman & Roni Gofman & Rafi Kalish & Amit Kanigel (Israel Institute of Technology), Cecile Uzan-Saguy (Technion IIT)
17:40 - 18:00	*Study on Contaminants Generated from Space Materials by Impingement of Atomic Oxygen:* Riyo Yamanaka & Yugo Kimoto (Japan Aerospace Exploration Agency, JAXA), Delphine Faye & Jean-Michel Desmarres (Centre National d'Etudes Spatiales)
18:30 - 21:00	**Welcome Reception at NATURALIS, Sponsored by ITL** see information on page 78

TUESDAY, SEPTEMBER 20TH, 2022

08:00	**Welcome desk opens**
08:45 - 09:00	*Overview of the ISMSE / ICPMSE Conference Proceedings submission and review process:* Malgorzata Holynska (ESA), Chair of the proceedings editorial board
9:00 - 10:30	**Session 3: Lunar environment and dust #1** Chaired by: Antonio Saverino (Thales-Alenia Space) & Ronald G Lee (Booz Allen Hamilton NASA-JSC)
09:00 - 09:30	**Highlight Talk:** *Complexities of the Lunar Dust Environment and Preparing Lunar Simulant for Adhesion Studies*: James Gaier (NASA Retired)
09:30 - 09:50	*Lunar Landing Systems Engine Plume Interactions with the Lunar Surface and Vehicle*: Carlos Soares & William Hoey & Greg Shallcross & John Anderson & John Alred (Jet Propulsion Laboratory, California Institute of Technology)
09:50 - 10:10	*Development of a Comprehensive Physics-Based Model for Study of NASA Gateway Lunar Dust Contamination:* Ronald Lee (Booz Allen Hamilton), Erica S. Worthy (NASA, Johnson Space Center), Emily M. Willis (NASA, Marshall Space Flight Center), Gary L. Brown (Barrios Technology), Fabrice Cipriani (ESA)
10:10 - 10:30	*Design of Innovative High-Performance Polymer for Passive Lunar Dust Mitigation:* Guido Saccone & N. Favaloro (Italian Aerospace Research Centre - CIRA), C. De Rosa & G. Di Stefano (Department of Chemical Science, Università degli Studi di Napoli Federico II)
10:30 - 11:00	**Coffee Break AM - Day 2**
11:00 - 12:30	**Session 4: Clean space and sustainability** Chaired by: Elisabeth Laurent (CNES) & Premysl Janik (ESA)

11:00 - 11:30	**Highlight Talk:** *Space debris removal by shape memory polymer composites*: Loredana Santo & Fabrizio Quadrini & Leandro Iorio (University of Rome Tor Vergata), Malgorzata Holynska (ESA)
11:30 - 11:50	*Contamination assessment of a freely expanding green propellant thruster plume:* Leonie J. Buntrock & Martin Grabe (DLR Institute of Aerodynamics and Flow Technology), Holger Fischer (ESA)
11:50 - 12: 10	*Aging Tests for Development of Markers Supporting Navigation:* László Szegedi & T. Bárczy & Á. Molnár & B. M. Somosvári & J. Szőke & K. Tamási & G. Tóth (ADMATIS LTD), A. Cipriano (Telespazio Belgium S.R.L. for ESA-ESTEC)
12:10 - 12:30	*Evaluation of material properties of solid rocket motor slag:* Yoshiki Matsuura & Kumi Nitta & Hirohide Ikeda & Masahiro Kinoshita (JAXA, Japan Aerospace Exploration Agency), Masumi Higashide (Hosei University)
12:30 - 14:00	**Lunch Day 2**
14:00 - 15:30	**Session 5: Contamination #2: Monitoring** Chaired by: Delphine Faye (CNES) & David Lansade (ONERA)
14:00 - 14:30	**Highlight Talk:** *Ariane 5 Fairing Preparations for James Webb Space Telescope (JWST) Launch:* Elaine Stewart & Eve Wooldridge (NASA), Olivier Schmeitzky (ESA), Jerome Bonhomme & Mats Madsen (RUAG)
14:30 - 14:50	*Study of the fluorescence of molecular contaminants by hyperspectral imaging*: Emmanuel Gouisset (Intraspec Technologies), Guillaume Rioland & Frédéric Bourcier & Fulvio Infante (Centre National d'Etudes Spatiales), Philippe Walter (Laboratoire d'Archéologie Moléculaire et Structurale)

14:50 - 15:10	*Porous materials based detector for siloxane monitoring*: Guillaume Rioland (CNES), P. Iacomi & E. Gulcay & S. Devautour-Vinot & G. Maurin (ICGM)
15:10 - 15:30	*A highly sensitive and fully automated method for the quantitative measurement of condensable molecular organic contamination (MOC)*: Markus Keller & Lia-Sabrina Berthold (Fraunhofer Institute for Production Engineering and Automation IPA)
15:30 - 17:00	**Coffee Break PM - Day 2 - Poster Presentations** See Poster Section (pages 39 to 65)
17:00 - 18:00	**Session 6: Flight experiments** Chaired by: Kim de Groh (NASA, USA) & Adrian Tighe (ESA)
17:00-17:20	*Flight experiment of the on-orbit material degradation detector (ORMADD) and operation of a shape-memory polymer actuator onboard the TAUSAT-1 cubesat*: Ronen Verker & Eitan Keren & Nati Refaeli & Yakov Carmiel & Asaf Bolker & David David & Sari Katz & Avner Haran & Irina Gouzman & Michael Murat (Soreq NRC), Elad Sagi & Dolev Bashi & Idan Fin & Meir Ariel & Yoav Simhony & Ofer Amrani (Tel-Aviv University)
17:20 - 17:40	*Initial Results of the MISSE-Flight Facility Polymers and Composites Experiment 1-4 (PCE 1-4)*: Kim de Groh (NASA Glenn Research Center), Bruce A. Banks (SAIC at NASA Glenn), Alexa S. Mills (Hathaway Brown School), Loredana Santo (University of Rome Tor Vergata)
17:40 - 18:00	*Euro Material Ageing - A European experiment on the International Space Station for materials science research and technology development*: Elisabeth Laurent & Sophie Perraud & Delphine Faye (CNES), Agnieszka Suliga & Johanna Wessing & Adrian Tighe & Sébastien Vincent-Bonnieu & Riccardo Rampini (ESA)

WEDNESDAY, SEPTEMBER 21ST, 2022

08:30	**Welcome desk opens**
08:45 - 09:30	**Christopher Semprimoschnig Memorial Lecture** *Materials Physics and Chemistry for Space Applications*: Riccardo Rampini, Ugo Lafont, Adrian Tighe (ESA)
9:30 - 10:30	**Session 7: Radiation & Synergistic Effects** Chaired by: Sophie Duzellier (ONERA) and Irina Gouzmann (Soreq)
09:30 - 09:50	*High-Energy Radiation Induced Outgassing Testing and Modeling for Jovian System Missions:* Carlos Soares & Anthony Wong & John Anderson & Daniel Fugett & Denis Thorbourn (Jet Propulsion Laboratory, California Institute of Technology)
09:50 - 10:10	*Synergetic effect of temperature and high energy radiation on the electrical properties of space used polymers*: Thierry Paulmier & P. Sarrailh (ONERA), Eric Dantras & Guilhem Rival (CIRIMAT - Université Toulouse III Paul Sabatier)
10:10 - 10:30	*Protons irradiations of perovskites materials and solar cells for space*: Carla Costa (CEA ONERA), Matthieu Manceau & Carine Roux & Fabien Chabuel & Romain Cariou (Univ. Grenoble Alpes, CEA, Liten, Campus INES), Thierry Nuns & Sophie Duzellier & Christophe Inguimbert (Univ. Toulouse, ONERA), Christophe Tenailleau (Univ. Toulouse, CIRIMAT)
10:30 - 11:00	**Coffee Break AM - Day 3**
11:00 - 12:30	**Session 8: Innovative Materials and Processes** Chaired by: Kristiina Jokela (Aurora Propulsion Technologies) and Christian Puig (Airbus)

11:00- 11:30	**Highlight Talk:** *Solar cell assembly monitoring via minimally intrusive optical fibre sensing during vacuum UVVUV radiation exposure*: Roger Groves (Delft University of Technology), Luigi Fazzi (Delft University of Technology ESA), Nuno Dias & Malgorzata Holynska & Adrian Tighe & Riccardo Rampini (ESA)
11:30 - 11:50	*Self-healing polymers for space applications*: Dijwar Yilmaz & David Lansade (ONERA/CNES Univ. Bordeaux, CNRS), Simon Lewandowski (ONERA), Sophie Perraud (CNES), Audrey Llevot & Stéphane Carlotti (Univ. Bordeaux, CNRS)
11:50 - 12:10	*Metamaterial-based smart and flexible Optical Solar Reflectors*: Sandro Mengali & M. Gaspari & M. Simeon & A. Urbani (Consorzio CREO), O. L. Muskens & K. Sun (Physics and Astronomy, University of Southampton), I. Zeimpekis (Optoelectronic Research Center, University of Southampton), A. Bialy & I. Czolkos (NIL Technolog), B. Alpat & G. Bartolini & M. Jamalipour (MAPRad srl), J. Frolec & T. Kralik (Institute of the Scientific Instruments of the CAS) F. Tessarin & M. Gottero & T. Schillaci (Thales Alenia Space)
12:10 - 12:30	*Electrically conductive PEEK 3D printing from ground to space qualification*: Ugo Lafont & Johanna Wessing & Bruno Delacourt & Riccardo Rampini (ESA), Maria Terol Sanchez (TU Delft)
12:30 - 14:00	**Lunch - Day 3**

14:00 - 14:45	**Round Table 1**: *New Space, Changing Space - benefits and challenges for the spacecraft materials community* Panel Chair: Kristiina Jokela (Aurora Propulsion Technologies) Panel Members: Deborah Mueller
14:45 - 15:00	**Short Break**
15:00 - 15:45	**Round Table 2**: *Future proofing spacecraft manufacture - moving towards a more sustainable materials supply chain* Panel Chair: Premysl Janik (ESA) Panel Members: Christian Puig (Airbus, France), Paola Bruno (OHB, Germany), Elisabeth Laurent (CNES)
15:45 - 16:15	**Coffee Break PM - Day 3**
16:15 - 17:00	**Round Table 3**: *Dealing with dust contamination - are we ready to return to the Moon?* Panel Chair: James Gaier (NASA, retired) Panel Members: Jacob Kleiman (ITL, Canada), Antonio Severino (Thales Alenia Space, Italy), Jean-Charles Mateo-Velez (ONERA)
19:00 - 22:30	**Conference Dinner at LOUWMAN MUSEUM** See information on page 78

THURSDAY, SEPTEMBER 22ND, 2022

08:30	**Welcome desk opens**
08:45 - 09:30	**Plenary Lecture:** ***Reach for the Stars! Space: The business and Beyond:*** Deborah Muel
9:30 - 10:30	**Session 9: Lunar environment and dust #2** Chaired by: James Gaier (NASA, retired) and Jacob Kleiman (ITL)
09:30 - 09:50	*Materials and Lunar Dust Interaction Issues in Ground-based Simulation of RAC Experiment on the Moon*: Jacob Kleiman & R. Ng (Integrity Testing Laboratory Inc), Z. Iskanderova (AZ Smart Technologies), L. Krishtein (Kvarc Corporation), R. Sodhi (Ontario Centre for Characterization of Advanced Materials (OCCAM))
09:50 - 10:10	*A Predictive Model of Lunar Gateway Molecular Contamination*: William Hoey & Carlos E. Soares & Maxwell G. Martin & Gregory S. Shallcross (Jet Propulsion Laboratory Jet Propulsion Laboratory, California Institute of Techology), Courtney A. Steagall (Jacobs), Erica S. Worthy (NASA Johnson Space Center)
10:10 - 10:30	*Compliant mechanisms for dust mitigation in Lunar hardware development: technology and material considerations*: Dorota Budzyń & Andrea Cammarano & Hossein Zare-Behtash (University of Glasgow), Aidan Cowley (European Astronaut Centre, ESA)
10:30 - 11:00	**Coffee Break AM - Day 4**
11:00 - 12:30	**Session 10: Focus on SLATS mission** Chaired by: Yugo Kimoto (JAXA) and Stephanie Remaury (CNES)

11:00- 11:30	**Highlight Talk:** *Impact of neutral atmosphere environment on SLATS*: Yugo Kimoto & Yuta Tsuchiya & Eiji Miyazaki & Aki Goto & Kazuki Yukumatsu & Shunsuke Imamura & Haruo Kawasaki & Masanori Sasaki (Japan Aerospace Exploration Agency, JAXA), Kumiko Yokota & Masahito Tagawa & Wataru Ide & Atsushi Fujita & Shohei Urakawa & Sasuga Horimoto & Santa Nishioka (Kobe University)
11:30 - 11:50	*N2-acceleration effect on atomic oxygen-induced polyimide erosion in sub-LEO observed by SLATSAOFS*: Kumiko Yokota & Masahito Tagawa & Wataru Ide & Atsushi Fujita & Sasuga Horimoto & Santa Nishioka & Keisuke Ezaki (Kobe University), Yuta Tsuchiya & Aki Goto & Kazuki Yukumatsu & Eiji Miyazaki & Yugo Kimoto (Japan Aerospace Exploration Agency, JAXA)
11:50 - 12:10	*Optical Property Changes in Thermal Control Films Observed by SLATSMDM*: Aki Goto & Kazuki Yukumatsu & Yuta Tsuchiya & Eiji Miyazaki & Yugo Kimoto (Japan Aerospace Exploration Agency, JAXA)
12:10 - 12:30	*Surface reaction of atomic oxygen with polymeric materials exposed on SLATSMDM*: Kazuki Yukumatsu & Aki Goto & Yuta Tsuchiya & Eiji Miyazaki & Yugo Kimoto (Japan Aerospace Exploration Agency, JAXA)
12:30 - 14:00	**Lunch - Day 4**
14:00 - 15:30	**Session 11: Contamination #3: Applications** Chaired by: Courtney Steagall (Jacobs Technology / NASA-JSC) and Riccardo Rampini (ESA)
14:00 - 14:30	**Highlight talk**: *Euclid ice contamination testing: Bruno Bras* (ESA)
14:30- 14:50	*Experimental and simulation study of erosion and induced contamination due to Hall thrusters:* Lucas Nicolas & Marc Villemant & Thierry Paulmier (ONERA), Gaëlle Giesen (CNES)

14:50 - 15:10	*Impact of particular and molecular contamination on light scattering:* Tobias Herffurth & Marcus Trost (Fraunhofer IOF), Monika Kroneberger & Albert Althammer & Sebastian Fray (OHB System AG)
15:10 - 15:30	*Electronic Nose, Data Evaluation for Cleanliness and Contamination Control in Cleanrooms, Machine Learning for decision making in production:* Andreas Helwig & Christian Keimel (Central Research & Technology - Airbus Defence and Space), Bahar Kilitoglu (Airbus Defence and Space GmbH), Yann Goueffon (Airbus Defence & Space SAS)
15.30 - 17.00	**Coffee Break PM - Day 4 - Poster Presentations** See Poster Section (pages 39 to 65)
17:00 - 18:00	**Session 12: Ground Facilities and Testing** Chaired by: Marianne Balat-Pichelin (PROMES) and Simon Lewandowski (ONERA)
17:00 - 17:20	*Investigation of Kapton Erosion by Atomic Oxygen in a Table-Top Shock Tunnel (TTST)*: Timothy Minton & Brian E. Riggs & Chenbiao Xu (University of Colorado Boulder), Eric C. Geistfeld & Thomas E. Schwartzentruber (University of Minnesota), Irina Gouzman (Soreq NRC)
17:20 - 17:40	*Outgassing of space materials at low temperature*: Guillaume Rioland & M. Hubert & B. Houret & D. Faye (CNES)
17:40 - 18:00	*Monopropellant Plume-Induced Contamination Testing for the Europa Lander Mission Concept*: Martin Grabe & Leonie J. Buntrock (DLR, Institute of Aerodynamics and Flow Technology), Carlos E. Soares (Jet Propulsion Laboratory, California Institute of Technology)

FRIDAY, SEPTEMBER 23RD, 2022

08:30	**Welcome desk opens**
09:00 - 09:50	**Session 13a: Standards and regulations** Chaired by: Christian Durin (CNES) and Malgorzata Holynska (ESA)
09:00 - 09:30	**Highlight Talk:** *Regulatory-driven materials' obsolescence risks and their impact on the European Space Sector*: Premysl Janik (ESA), Tim Becker & Oliver Reiff-Musgrove (REACHLaw, Ltd)
09:30 - 09:50	*New ECSS standard on adhesive bonding verification*: Elizabeth Estrada (Airbus Defence and Space), Premysl Janik (ESA)
9:50 - 10:30	**Session 13b: Long term storage** Chaired by: Christian Durin (CNES) and Malgorzata Holynska (ESA)
09:50 - 10:10	*Study of the impact of cleanroom environment on CFRPepoxy:* Sandra Fontorbes & Françoise Baldacci & Charlotte Perrin (Airbus Defence and Space SAS), Ugo Lafont & Yuryi Buntenko & Ricardo Martins & Sarah Rodriguez Castillo (ESA)
10:10 - 10:30	*Long-term storage (LTS) assessment of PFPE lubricants:* Milena Gleirscher & Archim Wolfberger, Sandra Schlögl & Andreas Hausberger & Eric Helfer & Gernot Oreski (Polymer Competence Center Leoben GmbH), Małgorzata Hołyńska (ESA)
10:30 - 11:00	**Coffee Break AM - Day 5**
11:00 - 12:10	**Session 14: Planetary environments** Chaired by: Stephane Gendron (CSA) and Leonie Buntrock (DLR)
11:00 - 11:30	**Highlight Talk:** *Material Challenges for Jovian Moon Missions:* Nora Low (NASA Jet Propulsion Laboratory, California Institute of Technology)

11:30 - 11:50	*High temperature atomic oxygen testing for ESA's Envision mission to Venus:* Agnieszka Suliga & Abel Brieva & Gabor Milassin & Adrian Tighe & Thomas Voirin (ESA)
11:50 - 12:10	*Planetary, Lunar, and Asteroid Natural Environment Testbed (PLANET) at NASA Marshall Space Flight Center:* Erin Hayward & Todd Schneider & Jason Vaughn & Patrick Lynn & Mary Nehls (NASAMarshall Space Flight Center)
12:10 - 13:00	**Closing Session** **Summary of the conference: ISMSE & ICPMSE organising committee** Closing address from the ISMSE & ICPMSE programme committee chairs: Mikko Nikulainen (ESA) & Jabob Kleiman (ITL) Preview of the next ISMSE ICPMSE: Sophier Duzellier (ONERA) and Jacob Kleimann (ITL)
13:00 - 14:30	**Lunch - Day 5**
14:30 - 16:00	**Technical Site Visits** Airbus Leiden TGL building (solar array assembly) Airbus NEBULA building (Launcher structures assembly) ESTEC Materials and Electrical Components Laboratories More information about the technical visits are provided on page 80

INVITED TALKS

MONDAY, SEPTEMBER 19TH 2022, OPENING SESSION

The Triceratops Project: From Great Plains to exhibit hall

Yasmin Grooters[1]
[1]*Chief preparator, Naturalis Biodiversity Center, Darwinweg 2, 2333 CR Leiden, The Netherlands*

Naturalis Biodiversity Center is a museum and a research Institute. In our museum the key is bringing science closer to our visitors and showing them how important nature preservation is. One of our ways of bringing science closer to the public is by our LiveScience Hall. In this hall you can find our Dinolab, a must see. Here you can talk with people working on real dinosaur bones.

Dinosaurs have been a fascination for all ages and a mystery for science. The Dinolab of Naturalis is currently working on 5 or 6 Triceratops skeletons consisting of almost 1200 bones. The Triceratops is one of the most iconic dinosaurs we know. Standing 9 meters long and about 2,5 meters high with 3 horns on his skull that ends with an impressive frill. Because there are no more living dinosaurs we need to compare them with other living beings of today. But with what do we compare an animal that went extinct 67 million years ago?

In the talk you will be taken through the process of finding and preparing these fossilized bones.

Biography:

Yasmin Grooters is a preparator in the Dinolab of Naturalis Biodiversity Center. She has followed and completed a Senior Secondary Vocational Education (MBO) training as a lab technician analyst. During her professional work as a molecular analyst for the testing of ELISA kits, she also volunteered in the Triceratops project at Naturalis. In 2019, she had the opportunity to apply for the position of chief preparator and to her delight, she was offered the job. Now, along with a colleague, she leads a team of volunteers in the Showlab and on field during excavations in the US.

Advanced Concepts for Future Space Application: From Biomimetics to Advanced Materials

Chris Broeckhoven[1] & Derek Aranguren van Egmond[1]
[1]*Advanced Concepts Team, ESA-ESTEC, Keplerlaan 1, 2200 AG Noordwijk, The Netherlands*
E-mail: Chris.Broeckhoven@esa.int; Derek.Aranguren@esa.int

A key requirement for future space missions is the development of novel, multifunctional materials and design methodologies that address interdisciplinary challenges. ESA's Advanced Concepts Team (ACT) identifies new research trends, not yet necessarily linked to space, that hold the potential to shape European space technologies in subsequent decades. The ACT explores innovative concepts and working methods to perform original research toward advanced space systems and scenarios. In this work, we exhibit the recent developments and synergistic fusion of two core research programs within the ACT: "Biomimetics" and "Advanced Materials for Space Infrastructure".

Firstly, we highlight the importance of biomimetics - a scientific approach to innovation by emulating nature - as an alternative means of informing new and realistic material technologies for space exploration. We showcase the application of biomimetics by introducing recent research on the multifunctional role of Namib Desert beetle elytra - hardened forewings involved in protection against solar irradiation, heat, impact and abrasion. By elucidating how the biomaterial microstructure in the elytron is adapted to life in extreme environments, we seek to unravel the physical principles underlying its biological, mechanical and optical multifunctionality. We investigate whether these principles can be replicated, in part or in their entirety, into futuristic materials adapted for the multifaceted environmental pressures posed in planetary exploration. Most importantly, our approach demonstrates how biological knowledge together with the use of specimens from natural history collections can play a crucial role for the practical advancement of biomimetics in space applications.

Finally, we contextualize the Namib beetle project within the scope of materials research conducted at the ACT. We demonstrate how the tandem use of biomimetics, artificial intelligence, generative design, and functional chemistry, allows materials scientists to navigate increasingly complex parametric design spaces. In this new age of digital manufacturing, these tools allow us to "catch-up" to the devices and structures that can now be reliably fabricated, thereby enabling multifunctional material solutions to previously unsolvable problems.

Biographies:

Chris Broeckhoven is an Internal Research Fellow in Biomimetics in the Advanced Concepts Team at the European Space Agency. His current research focusses on advancing the concept of biomimetics to a more encompassing, evolutionary-informed approach that exploits the full potential of biodiversity. He obtained his PhD in Zoology from Stellenbosch University, South Africa and continued his research on the functional morphology and evolution of animal body armour as a postdoctoral fellow at the University of Antwerp, Belgium. His most exciting research lies at the interface between these two research interests, with natural protective structures being the main inspiration for this work.

Derek Aranguren van Egmond is a young graduate researcher with the ESA Advanced Concepts Team. His subject domain is "Advanced Materials for Space Infrastructure", wherein his work intersects functional material chemistry, with advanced manufacturing and computational material design. He is passionate about combining digital fabrication tools and bioinspired design to generate new design rules for "growing" matter on other worlds. Derek holds a MSc degree in Materials Science and Engineering from the University of Toronto, Canada, where he conducted research on bioinspired structural materials. There he explored the role of disorder and topological design on the mechanical properties of porous materials in nature. Prior to joining ESA he worked as a research officer with the National Research Council of Canada, developing new stimuli-responsive materials by multi-material 3D printing.

S&MA activities of JAXA and future plans

Shinichiro Ichimaru, Yuji kado and Yasuhiro Nakamura *(JAXA, Japanese Space Agency)*

S&MA (Safety and Mission Assurance) provides independent oversight and supports throughout every project and program to ensure the safety and to enhance the mission success. S&MA addresses system safety, reliability, quality assurance, sustainable space activities and so on.

JAXA S&MA department supports the success for the missions of JAXA and Japanese industries. In order to ensure the success of their challenging future missions, S&MA department has collected project needs and required new technologies from S&MA aspects, and identified technical problem from a safety and reliability perspective.

S&MA roadmap was created for visualizing near and long-term milestone of our activities. The summary of the S&MA roadmap will be presented.

Biography:

Shinichiro Ichimaru is an engineer in the Mission Assurance Engineering group, Safety and Mission Assurance(S&MA) Department for Japan Aerospace Exploration Agency (JAXA). He received a master's degree in Materials Process Engineering from Kyushu University in March 2009. In this current position, he is working for safety and mission assurance, and independent assessment for the Lunar Polar Exploration Mission, HTV-X and so on. Also he works on the research of Lead-Free Parts application and works for development of the long-term research planning for new S&MA technologies.

Trends in European research on space materials

Malgorzata Holynska, Adrian Tighe, Riccardo Rampini (ESA, European Space Agency)
Materials Physics and Chemistry Section, ESA-ESTEC, Keplerlaan 1, 2200 AG Noordwijk, The Netherlands
E-mail: Malgorzata.Holynska@esa.int

The growing requirements of space missions push developments of new technologies addressing a variety of space environments and technology themes. These include topics from ground environment, through re-entry, very low earth orbit, moon, mars till the outer solar system. Currently also a European roadmap is drafted in materials' survivability by a dedicated ESA workgroup involving also a number of industries implementing ESA R&D activities. The selected aspects cover a range from materials and coatings for general protection, smart sensors, modelling of environmental aging, on-ground testing and the recent trend of virtual testing, in-flight testing, materials designed to withstand extreme environments, coatings resistant to dust, re-usable and demisable materials till long-term storage effects on space materials. Highlights from ESA programmes such as Voyage 2050 will also be presented.

Biography:

Dr. Malgorzata Holysnka specializes in materials chemistry. Her interests include materials and processes for spacecraft applications. Presently she supports ESA space missions, as well as research & development activities at the European Space Research and Technology Center (Noordwijk, the Netherlands) as materials and processes engineer. Previously she obtained her Ph.D. from the University of Wroclaw (Poland), Department of Chemistry, in new rhenium-based materials, completed a postdoc fellowship and a habilitation at the University of Marburg (Germany) in new magnetic materials.

Spacecraft materials development and environmental effect evaluation in CAST

Bohan Wu[2], Chengan Wan[1], Yigang Ding[2], Tuo Ping[1], Zilong Jiao[2], Xiaoyu Shen[1], Dongsheng Yang [2], Yang Zuo[1], Zhenlu Zhao[1], Xiaoxi Zhu[1]

[1] *Beijing Spacecraft Manufacturing Co., Ltd., BSC*

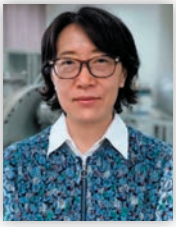
[2] *Beijing Institute of Spacecraft Environment Engineering, BISEE*

In recent years, China's space technology has developed rapidly. The ongoing projects include the Chinese space station, lunar, Mars, and deep space exploration missions. The development of these space missions addresses new challenges to spacecraft materials development and environmental effect evaluation. In this presentation, the spacecraft materials development and the environmental effect evaluation were completed by BSC and BISEE respectively.

The spacecraft materials developments are presented, including themes of high strength structural materials, thermal protection materials, structural-functional integration materials and various coatings covering topics of thermal control coatings, functional protection coatings, and optical coatings, etc. Along with the development of new materials, the detection and characterization of materials have also been developed and improved. They are advanced non-destructive testing technologies such as digital ray, full-mode infrared thermography, laser ultrasonic, electronic shearography, and terahertz, etc.

The ground-based environmental test technologies are presented, involving electron and proton radiations, UV, AO, plasma, out-gassing, and contamination monitoring. In addition, a wide range of property degradation effects of spacecraft materials are also presented. A database has been established to store, analyze, and share the experimental data. The fluxes of certain orbital environments are simulated through the test particle Monte-Carlo method. The risk of spacecraft in orbit is analyzed by combining the test results with computational simulations. Furthermore, an ISO standard of Space system - Environmental testing for spacecraft thermal control materials is reported.

Biography:

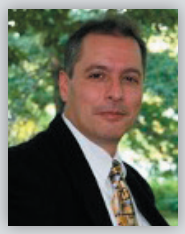


Dr. Bohan Wu has been working as a senior engineer at Beijing Institute of Spacecraft Environment Engineering since 2014. Her expertise is ground-based space environmental simulation, space material evaluation, and development of AO protection materials. She worked as a Postdoctoral Research Associate at the University of Basel, Switzerland and at Montana State University, USA. She got her PhD in Physical Chemistry at the University of Nottingham, UK.

Contamination Control and Materials Development Challenges for NASA Deep Space Missions

Carlos Soares[1], William Hoey[1], John Alred1, Bryan McEnerney[1], Nora Low[1], Courtney Steagall[2]
[1] Jet Propulsion Laboratory (JPL), 4800 Oak Grove Dr., Pasadena, CA, USA.
[2] Jacobs / NASA JSC-ES411
E-mail: Carlos.e.soares@jpl.nasa.gov

NASA's current emphasis on deep space programs, with increasing science instrument sensitivities, has introduced contamination control and materials development challenges that are being worked across multiple NASA programs, centers, and partners. These challenges include lunar dust modeling, lunar dust effects/testing, material degradation in extreme environments, and molecular contamination modeling/analysis. Highlights from recent flight project developments and concept missions will be presented.



Biography:

Carlos Soares is a Principal Engineer and the Technical Group Supervisor for Contamination Control Engineering at NASA's Jet Propulsion Laboratory (JPL). At JPL, he leads a multidisciplinary group of engineers and scientists which support all JPL missions with contamination control, computational physics and contaminant transport models, and analysis tools/capabilities. Prior to joining JPL, Carlos worked on human spaceflight for over 25 years, including Shuttle, Shuttle-Mir, and the International Space Station (ISS) program.

CHRISTOPHER SEMPRIMOSHNIG MEMORIAL LECTURE

WEDNESDAY 21ST SEPTEMBER 08:45 - 09:30

Materials' Physics and Chemistry for Space Application

Ugo Lafont, Adrian Tighe, Riccardo Rampini, Mikko Nikulainen (ESA, European Space Agency)
Materials Physics and Chemistry Section, ESA-ESTEC, Keplerlaan 1, 2200 AG Noordwijk, The Netherlands

This lecture is dedicated to the memory and legacy of our respected colleague Christopher Semprimoshnig, who sadly passed away in June 2020 at the age of 52, and leaves behind his wife Carla, and two children Sophie and Lucas. Christopher was a long established member of the ISMSE and ICPMSE organising and programme committees, and he will have been well known to many of the conference delegates. The intention of the lecture is to showcase the general field of "Materials' Physics and Chemistry for Space Applications" which Christopher dedicated his career to, we well as to provide some personal memories and tributes from members of the community. We will cover many of the diverse technical topics he studied over the years together with his team within the European Space Agency, as well as with many international partners in academia, national space agencies, research institutes and industries. The first part of the lecture will be related to new materials development and material combination in the field of energy conversion, structural monitoring, self-healing concepts, materials aging and processing. The second part will focus on the efforts made worldwide to assess material behavior and reliability in the space environment, highlighting the specific ground-based experiments designed for this purpose.

This abstract and the lecture is based on the content of the Special Issue of the CEAS space journal: Materials' Physics and Chemistry for Space Application (Volume 13, issue 3, July 2021). Material reproduced with permission.

PLENARY LECTURE

THURSDAY 22ND SEPTEMBER 08:45 - 09:30

REACH FOR THE STARS! SPACE: THE BUSINESS AND BEYOND

The space environment provides many challenges, which can be used as opportunities for new innovation or can negatively impact the system. In operative space industry – from conceptual design to production and up to the launch pad – there are many requirements to fulfill. These can either accelerate change due to crisis or reactively/proactively push technologic change through new opportunities. A unique example is the development of 3D printed Silica Aerogel in record time, enabling ground-breaking properties for thermal insulation applications. Materials and processes are key drivers in the product development value chain of any industry. What challenges are there in a product-focused project matrix organisation?

The Swiss Space ecosystem is relatively small compared to other European member states, however it is focused on high technology niche innovation. A record of more than 50'000 new start-ups has been registered within one year (2021), increasing venture capital investment up to CHF 3.1 bio. The industry employs more than 400'000 individuals in companies founded less than ten years ago (total amount of companies registered in CH are approx. 600'000 to date). Many of these companies have (Earth) technologies and services, which could be used for Space applications. A small glimpse of what is done at the Swiss Federal Institute of Technology in Zurich (ETH Zürich) in the field of materials and process innovation can be a trigger for future collaborations. The main top five research fields are in Earth Sciences, Physical Sciences, Engineering, Biological Sciences, Information & Computing Sciences. What are nowadays space industry trends?

How must businesses innovate in order to have a competitive advantage in the new space era?

Being passionate and curious about aerospace, my entire career has been oriented towards gazing at the stars and beyond. There have been many obstacles throughout my past. Nevertheless, inspiring our future leaders and transferring our knowledge, as well as our lessons learned are keys to success. In our fast changing world, diversity and inclusion are necessary to obtain a balanced and innovative leadership, generating outstanding results. The current situation in Switzerland shows 0% of female SME CEOs. What does it take to change the current mindset?

Biography:

Deborah Mueller is a Materials Scientist. She has held positions at the Swiss Polytechnical University in Lausanne (EPFL) and as a Research YGT at the European Space Research and Technology Center (European Space Agency). She has 10 years of Space Industry experience having had different positions such as Launch Campaigns Manager for Ariane 5, Vega and Soyuz Upper Composite Assembly, integration and Launch at the European Spaceport in Kourou, French Guyana, then Product Assurance Engineer and Production Engineer for Satellite Mechanisms. Following this she was Director of Innovation and Business Development at a large Swiss Space company (RUAG Space, now Beyond Gravity), where she was a Member of a Senior Leadership Team. Currently she is back to Research at Swiss Polytechnical University in Zürich (ETHZ) - building up Space at ETHZ, Industrial advisor for Space Exchange Switzerland Consortium and member of Swiss Delegation for European Space Technology Harmonisation. Lately, she has been an ESA Astronaut Candidate, and she is a passionate private pilot, sports & adventurer enthusiast and musician (piano and alto-saxophone)

POSTER SESSIONS

Poster sessions will be held in the Poster Room on the 7th floor of the building (accessible by the main stairs or elevator)
There are two designated poster sessions on:
Tuesday, September 20th, 2022, 15:30 - 17:00
Thursday, September 22nd, 2022, 15:30 - 17:00

The list of posters is shown on page 41

- Posters are ordered numerically in the programme booklet. Poster stands will be allocated according to poster number. The list will be provided in the poster hall.
- Refreshments will be available in the poster hall during the poster sessions.
- Poster presenters are encouraged to place their posters on their allocated poster stand during the first day of the conference, so that delegates can also browse the posters outside of the designated sessions. Posters can be installed at the start of the day or during coffee and lunch breaks. Poster presenters are requested to remove their poster from the stand by the end of the conference (14:00 on Friday 23rd September).
- Poster presenters are kindly requested to be in attendance at their poster for the duration of their designated session.

POSTER SESSIONS

A detailed programme with all abstracts (incl. posters) is available online at the conference website (https://atpi.eventsair.com/ismse15/). Each abstract can be read online and downloaded on your device.

Follow the QR code below to go directly to the online programme.

Poster No.	Paper Title (alphabetically ordered)	All Authors
1	3D Printing of Bismaleimide-Based Dielectric Materials for Space Applications	Dr. Nurit Atar[1], Dr Eitan Grossman[1], Dr Yuval Vidavsky[1], Dr Ronen Verker[1], Dr Asaf Bolker[1], Dr Irina Gouzman[1] [1]*Soreq NRC, Yavne, Israel*
2	3D Printing of High Performance Thermosets for Space Applications	Dr. Yuval Vidavsky[1], Dr. Eitan Grossman[2], Dr. Nurit Atar[1], Dr. Ronen Verker[1], Dr. Irina Gouzman[1] [1]*Soreq NRC, Yavne, Israel,* [2]*Noga 3D Innovations LTD, Rosh Haayin, Israel*
3	A cryogenic method for testing thermal-radiative properties of surfaces for space probes	Dr. Jiří Frolec[1], Dr. Tomáš Králík[1], Bruno Bras[2], Mauricio Portaluppi[2] [1]*Institute of Scientific Instruments of the Czech Academy of Sciences, Brno, Czech Republic,* [2]*TEC-QEE Materials' Physics & Chemistry Section at ESTEC (European Space Research and Technology Centre), Noordwijk, The Netherlands*

4	A Ground-Based Test Facility For Simulating Atomic Oxygen Effects in Low Earth Orbit (LEO)	Dr. David Oakes[1], Dr. Daniel Hewett[1], Dr. Dan Wang[2], Dr. Timothy Hall[2], Dr. Maria Inman[2] [1]*Physical Sciences Inc., Andover, United States*, [2]*Faraday Technology Inc. , Englewood, United States*
5	Alloy design for stellar-radiation environment	Mr. Patrick Willenshofer[1], Mr. Matheus A. Tunes[2], Mr. Stefan Pogatscher[1] [1]*Chair of Nonferrous Metallurgy, Montanuniversitaet Leoben, Leoben, Austria*, [2]*Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, United States of America*
6	An Application of Atomic Oxygen Beam on the Ground to Modify the Surface Properties of Polymeric Materials in Terms of Nano and Micro Scale Morphological Fabrication	Dr. Eiji Miyazaki[1], Ms. Miki Nishimoto[1], Dr. Keiichi Yanagase[1], Ms. Aki Goto[1] [1]*Japan Aerospace Exploration Agency, Tsukuba, Ibaraki, Japan*
7	Analysis of micron size space debris impacts on materials: comparison of ground based testing and in-flight results	Ms. Kristien Peeters[1], Mr. Ricardo Martins[1], Dr. Adrian Tighe[1] [1]*ESA-ESTEC, Noordwijk, Netherlands*

8	Annealing effects on Alpolyimide adhesion in flexible optical solar reflectors	Dr. Megan Cordill[1], Dr. Patrice Kriemi[1], Gabor Milassin [1]*Erich Schmid Institute For Materials Science, Leoben, Austria*
9	Assessing the effects of critical parameters in standoff bonding	Mr. Orfeas Batzilis[1,2], Dr. Sarah Rodriguez[1], Mr. Nicolas Blasakis[3], Dr. Athanasios Baltopoulos[3], Dr. Premysl Janik[1], Dr. Riccardo Rampini[1], Adam Stimoniaris[2] [1]*European Space Agency - ESTEC, Noordwijk, The Netherlands,* [2]*University of Western Macedonia, Kozani, Greece,* [3]*Adamant Composites Ltd, Patra, Greece*
10	Assessment of PAC and MOC contamination behavior of polymeric foil materials regarding long-term storage scenarios	Dr. Markus Keller[1], Dr. Axel Müller[2], Dr. Harald Steininger[2], Kevin Hildenbrand[1], Claudia Breuninger[1], Yvonne Holzapfel[1] [1]*Fraunhofer IPA, Stuttgart, Germany,* [2]*OHB System AG, Wessling, Germany*
11	Atomic Layer Deposition Coatings - Protection Against Atomic Oxygen in Space	Dr. Marko Pudas[1], Dr. Johanna Wessing [1]*Picosun Oy, Masala, Finland*

12	Atomic oxygen density variation measured by SLATSAOFS: Comparison of flight data and atmospheric model predictions	Dr. Masahito Tagawa[1], Mrs Kumiko Yokota[1], Mr. Atsushi Fujita[1], Mr Wataru Ide[1], Dr. Yasunobu Miyoshi[2], Mr Yuta Tsuchiya[3], Mrs Aki Goto[3], Mr. Kazuki Yukumatsu[3], Dr Eiji Miyazaki[3], Dr Yugo Kimoto[3] [1]*Kobe University, Kobe, Japan,* [2]*Kyushu University, Fukuoka, Japan,* [3]*JAXA, Tsukuba, Japan*
13	Atomic Oxygen in LEO orbits: advantages and limitation of the existing modelling techniques	Mr. Bayrem Zitouni[1] [1]*Ohb, Bremen, Germany*
14	Augmenting the outgassing screening test with the use of QCMs	Mr. Mircea Alexandru Helici[1], Mr. Orcun Ergincan[1], Mr. Abel Brieva[1], Mr. Riccardo Rampini[1] [1]*ESA, Noordwijk, Netherlands*

15	Characterization of Novel Spacecraft Materials aboard the Materials International Space Station Experiment-Flight Facility (Preliminary Results)	Mr. Ryan Hoffmann[1], Miles Bengtson[2], Jainisha Shah[3], Daniel Engelhart[4], Sydney Collman[3], Gregory Badura[5], Heather Cowardin[6], Timothy Scott[7], Jacqueline Reyes[8], Elena Plis[3,5] [1]*Air Force Research Lab, Kirtland AFB, United States*, [2]*National Research Council at Air Force Research Laboratory, Kirtland AFB, USA*, [3]*Assurance Technology Corp, Carlisle, USA*, [4]*University of New Mexico, Albuquerque, USA*, [5]*Georgia Tech Research Institute (GTRI), Atlanta, USA*, [6]*NASA Johnson Space Center, Orbital Debris Program Office, Houston , USA*, [7]*DuPont de Nemours, Durham, USA*, [8]*University of Texas at El Paso, El Paso, USA*
16	CO2 jet as standard cleaning method for cleanrooms	Dr. Bahar Kilitoglu[1], MSc Cagla Akin[1], Dr. Christiane Schleifenbaum[1], Dr. Thomas Jordan[1] [1]*Airbus Defence and Space GmbH, Immenstaad, Germany*

17	Coated thin films in space applications	Dr. Patric Seefeldt[1], Dr. Maciej Sznajder[1], Udayan Banik[2], Thomas Renger[1], Tom Spröwitz[1], Dr. Matthias Fahland[3], Tobias Vogt[3] [1]*German Aerospace Center (DLR), Institute Of Space Systems, Bremen, Germany,* [2]*German Aerospace Center, Institute of Networked Energy Systems, Oldenburg, Germany,* [3] *Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology, Dresden, Germany*
18	Commercial optical coatings in space	Dr. Johanna Wessing[1], Bruno Bras[1], Nuno Dias[1], Dr. Adrian Tighe[1] [1]*ESA, Noordwijk, Netherlands*
19	Comparison between purged and vacuum bake-out efficiency	Miss Szilvia Szmolka[1], Mr Bruno Bras[1], Mr Riccardo Rampini[1] [1]*European Space Agency ESTEC, TECQEE, Noordwijk, Netherlands*
20	Contamination assessment of a freely expanding green propellant thruster plume	Dr. Martin Grabe[1], Leonie Buntrock[1], Holger Fischer[2] [1]*DLR, Göttingen, Germany,* [2]*ESA-ESTEC, Noordwijk , The Netherlands*

21	Contamination Level Prediction: Progress in Species Separation by TGAMS	Dr. David Lansade[1] [1]*Onera, Toulouse, France*
22	Contamination modelling and validation: outgassing and plume numerical status	Mr. Bayrem Zitouni[1] [1]*OHB, Bremen, Germany*
23	Degradation of solar absorptivity of thermo-optical materials contaminated by electric propulsion	Mme. Delphine Faye[2], Mrs Virginie Inguimbert[1], Mr. Mohamed Belhaj[2], Mr. Marc Villemant[1], Mrs. Véronique Perrin-Bailly[3], Mrs Sylvie Brosse[3] [1]*Onera, Toulouse , France,* [2]*CNES, Toulouse Cedex 9, France,* [3]*Thales Alenia Space, Cannes la Bocca, France*
24	DEGRADATION OF SPACECRAFT THERMAL CONTROL MATERIALS UNDER MEO RADIATION ENVIRONMENT	Mr. Yigang Ding[1], Dr. Zicai Shen[1], Mr. Xiangyu Nie[1], Mr. Yongtai Zhang[1] [1]*Beijing Institute of Spacecraft Environment Engineering, Beijing, China*
25	Design to cleanliness for cryogenic subsystems	Dr. Bahar Kilitoglu[1], Dr. Thomas Jordan[1], Raphael Naire [1]*Airbus Defence and Space GmbH, Immenstaad, Germany*

26	Development of conducting thermo-optical white coatings (COIN- COAT)	Dr. Frank Meyer[1], Dr. Stefan Faber[1], Dr. Michael Opsölder[1], Dr. Adrian Tighe[2] [1]*Ceranovis GmbH, Saarbruecken, Germany,* [2]*European Space Agency, ESA ESTEC , Noordwijk, Netherlands*
27	Development of PEEK-Metal reinforced mechanical components for space applications.	Dr. Maciej Ossowski[1], Sergey Yatsunenko[2], Anatolii Iatsunenko[2], Michał Siemaszko[3], Dawid Piastowski[3], Józef Krysztofik[4], Maciej Malicki[4], Ugo Lafont[5] [1]*Astronika, Warsaw, Polska,* [2]*CRIDO R&D, Warsaw, Poland,* [3]*Zortrax, Olsztyn, Poland,* [4]*Lukasiewicz Research Network - Institute of Avition, Warsaw, Poland,* [5]*European Space Agency, Noordwijk, Netherlands*
28	Effects of atomic oxygen on spacecraft materials in planetary atmospheres	Agnieszka Suliga[1], Abel Brieva[1], Gabor Milassin[1,] Adrian Tighe[1] [1]*ESA-ESTEC, Noordwijk, Netherlands*

29	Effects of Ionising Radiation on Ceramic Colour Standards: Implications for Space and Planetary Imaging	Dr. Patricio Becerra[1], Dr. Isidre Mateu[2], Lea Halser[2], Dr. Antoine Pommerol[2], Lee Bullock[3], Dr. Kjartan Kinch[4], Dr. Morten Bo Madsen[4], Daniel Kraehenbuehl[1], Dr. Stephane Beauvivre[1] [1]*Micro-cameras & Space Exploration, Neuchâtel, Switzerland,* [2]*Physikalisches Institut, University of Bern, Bern, Switzerland,* [3]*Lucideon Ltd. , Stoke-on-Trent, United Kingdom,* [4]*Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark*
30	Effects of Simulated Solar Wind on Polymethyl Methacrylate Thin Film	Dr. Lidia Mezzina
31	Enhanced photocatalytic antibacterial activity of TiO2-based coating under visible light for space application	Ms. Federica Arena[2], Mrs. Fabio Di Fonzo[2], Ms Malgorzata Holynska[3], Mrs. Mirko Prato[1] [1]*Istituto Italiano di Tecnologia (IIT), Center for Convergent Technologies (CCT), Genova, Italy,* [2]*Istituto Italiano di Tecnologia (IIT), Center for Nano Science and Technology (CNST), Milano, Italy,* [3]*European Space Research and Technology Centre (ESTEC), Noordwijk, Netherland*

32	ESA's "Open Lab" Atomic Oxygen Testing Campaign	Dr. Agnieszka Suliga[1], Dr Johanna Wessing, Dr Abel Brieva, Mr Gabor Milassin, Dr Adrian Tighe *[1]ESA-ESTEC, Noordwijk, Netherlands*
33	Establishing a 3D BRDF database for Acktar's ultra-black, space qualified coatings and foils	Alexander Telle[1] *[1]ACM Coatings GmbH (subsidiary of Acktar Ltd), Naumburg (Saale), Deutschland*
34	Euclid Cleanliness and Contamination Control	Mauricio Portaluppi[1], Sandra Fontorbes[2], Antonio Saverino[3], Riccardo Rampini[1] *[1]ESA-ESTEC, Noordwijk, Netherlands, [2]Airbus Defence and Space, Toulouse, France, [3]Thales Alenia Space Italy, Turin, Italy*
35	Euro Material Ageing - Ground based testing and selection of the ESA flight candidate materials	Dr. Agnieszka Suliga[1], Dr Johanna Wessing, Dr Sebastien Vincent-Bonnieu, Dr Adrian Tighe, Mr Riccardo Rampini *[1]ESA-ESTEC, Noordwijk, Netherlands*
36	Evaluation of advanced cleaning processes for sensitive surfaces in optical instrumentation	Mr. David Cheung[1], Mrs. Delphine Faye[2] *[1]ECP, Montpellier, France, [2]CNES, Toulouse, France*

37	Exposure of materials on ISS: presentation of EMA CNES samples	Dr. Elisabeth Laurent[1], Dr Sophie Perraud, Dr Delphine Faye [1]*CNES, Toulouse cedex 9, France*
38	Extensive Proton Spectra for Interplanetary Space	Mr. Erik Marten Klein
39	Externally Exposed Tape Degradation Evaluation For The NASA Europa Clipper Mission	Dr. Andrew Gerger[1] [1]*Johns Hopkins University Applied Physics Laboratory, Laurel, United States*
40	FIAMMA Flammability facility for Future Human Missions Spaceflight	Dr. Antonia Simone[1], Mrs Lucia Propato[1], Mr Mauricio Portaluppi[2], Mrs Lucia Grizzaffi[1], Mr Cathal Mooney[2] [1]*Thales Alenia Space Italia, Turin, Italy,* [2]*European Space Research and Technology Centre ESTEC , Noordwijk, , Netherland*

41	First-Surface Flexible Optical Solar Reflectors	Dr. Sandro Mengali[1], Mirko Simeoni[1], Alessandro Urbani[1], Matteo Gaspari[1], Michele Magistretti[2], Cesare Sabato[2], Marco Ivagnes[3], Fausto Lucantonio[3], Andrea Ferrero[4], Marina Gentile[4], Marco Gottero[4], Federica Tessarin[4] [1]*Consorzio Creo, L'Aquila, Italy,* [2]*ODL Srl, Brembate di Sopra (Bergamo), Italy,* [3]*Thales Alenia Space, L'Aquila, Italy,* [4]*Thales Alenia Space, Torino, Italy*
42	High temperature characterisation of improved fidelity lunar regolith simulants	Ms. Jennifer Sutherland[1], Dr. Axel Müller[2], Prof. Donald Dingwell[3] [1]*Institut Laue-Langevin, Grenoble, France,* [2]*OHB System AG, Weßling, Germany,* [3]*Ludwig Maximilian University of Munich, Munich, Germany*
43	High Temperature High Voltage Potting Adhesive	Geoffroy Petiniot[1], Eng. Isabelle Liémans[1], Eng. Déborah Daclin[1], Dr. Malgorzata Holynska[2], Eng. Andreas Franke[2], Eng. Virginie Cesar-Auguste[2] [1]*Thales Alenia Space Belgium, Mont-sur-marchienne, Belgium,* [2]*ESA, Noordwijk, The Netherlands*

44	Ice contamination in cryostats	Mrs. Mathilde Marcon[1] [1]*Thales Alenias Space, Cannes, France*
45	Improvement of high heritage conformal coatings to ease the quality inspection: MAP® ATOX 41-BUV, MAPSIL® 213-BUV and MAPSIL® QS1123 THIXO-BUV	Dr. Guillaume Sierra[1] [1]*Map Space Coatings, Mazeres, France*
46	Interaction Study of Energetic Protons and Electrons with the Vacuum Ultra Violet Source used in the Complex Irradiation Facility	Mr. Erik Marten Klein[1], Dr. Patric Seefeldt[2], Dr. Dr. Ing. Maciej Sznajder[2], Dr. Peter Spietz[2], Mr. Thomas Renger[2] [1]*University Of Bremen, Insitut of Space Systems, Bremen, Germany,* [2]*German Aerospace Center (DLR), Insitut of Space Systems, Bremen, Germany*
47	Interactions between Atomic Oxygen and Polymers Analyzed by Molecular Dynamics Simulations	Dr. Aki Goto[1], Ms. Miki Nishimoto[1], Dr. Keiichi Yanagase[1], Dr. Eiji Miyazaki[1] [1]*Japan Aerospace Exploration Agency, Ibaraki, Japan*
48	Investigation of long-term storage of space materials for future constellation missions	Dr. Theo Henry[1], Dr. Malgorzata Holynska[1] [1]*ESA, Noordwijk, Netherlands*

49	Investigations on contamination repellent coatings (CRC) for space applications - First results	Dr. Frank Meyer[1], Dr. Michael Opsölder[1], Antonio Saverino[2], Yuriy Butenko[3], Bruno Delacourt[3], Theo Henry[3] [1]*Ceranovis GmbH, Saarbruecken, Germany,* [2]*Thales Alenia Space , Torino, Italy,* [3]*European Space Agency, ESA ESTEC , Noordwijk, Netherlands*
50	JWST as a case study on long-term storge resilience of Acktar coatings	Ms. Irene Katsnelson[1], Ms. Dina Katsir[1] [1]*Acktar, Kiryat Gat, Israel*
51	Limits of Detection in MOC Measurements.	Dr. Michal Malicki[1], Mr Alex Bolkhovitinov[1], Mr Gerard Van Papendrecht[1], Mr Olivier Schmeitzky[1], Mr Riccardo Rampini[1] [1]*ESA, Noordwijk, Netherlands*
52	Links between outgassing of materials and LEOP venting analyses	Dr. Christopher Laurent[1], Mr Christophe Theroude[1], Mr Alexis Dalmon[1] [1]*Airbus Defence And Space, Toulouse, France*

53	Loss Assessment for Solar Panel Performance in LEO	Dr. Nassima Khorchef[1], Mr. Rick Kimber[2], Dr. Youcef Bentoutou[1] [1]*Satellite Development Centre-CDS, Algerian Space Agency-ASAL, Oran, Algeria,* [2]*Surrey Satellite Technology Ltd- SSTL, Guildford, GU2 7YE , United Kingdom*
54	MAP® SCK5N: a RF transparent coating for space antennas	Dr. Guillaume Sierra[1] [1]*Map Space Coatings, Mazeres, France*
55	Materials Inspection of the ISS Columbus trunnion scuff plate MLI	Mr. Cathal Mooney[1], Mr Nuno Dias[1] [1]*ESA, Noordwijk, Netherlands*
56	Poster withdrawn	

57	Moisture and outgassing barrier for polymeric and composite materials	Mr. Michal Delkowski[1,2], Dr. Christopher T.G. Smith[2], Dr. José V. Anguita[2], Mr. Bruno Bras[3], Mr. Ricardo Martins[3], Dr. Orcun Ergincan[3], Dr. Riccardo Rampini[3], Dr. Shumit Das[3], Mr. Simon Blake[3], Mr. Graham Coe[3], Prof. S. Ravi P. Silva[2] [1]*Airbus Defence and Space, Immenstaad, Germany,* [2]*Advanced Technology Institute, University of Surrey, Guildford , United Kingdom,* [3]*European Space Research and Technology Centre (ESTEC), Keplerlaan 1, PO Box 299, 2200 AG Noordwijk, The Netherlands*
58	Molecular contamination control for Exomars 2022 Mission	Dr. Arianna Pandi[1], Eng. Antonio Saverino[1], Eng. Marco Giuliani[1], Dr. Ilaria Locantore[1] [1]*Thales Alenia Space, Torino, Italy*
59	Multifunctional adhesives through nano-enabling for use in space	Nicolas Blasakis[1], Dr. Athanasios Baltopoulos[1], Dr. Antonios Vavouliotis[1] [1]*Adamant Composites Ltd., Patras, Greece, Greece*

60	Novel ultrathin, radiation resistant nanocomposite structures for space applications	Miss Mayra Yadira Rivera Lopez[1], Prof. Ian Hamerton[1], Prof. Fabrizio Scarpa[1] [1]*University of Bristol, Bristol, United Kingdom*
61	On-orbit use of engineering polymers	Mr. Aaron Moloney[1], Ms. Anna Daurskikh[2], Dr. Declan Devine[1], Mr. Francesco Caltavituro[3], Mr. Luca Facciolati[3], Mr. Pedro Almeida[4], Mr. Pedro Teixeira[4], Mr. Renato Silva[4], Dr. Ugo Lafont[5] [1]*Technological University of the Shannon: Midlands Midwest, Athlone, Ireland,* [2]*Azimut Space GmbH, Berlin, Germany,* [3]*OHB System AG, Bremen, Germany,* [4]*Beeverycreative, Gafanha de Aquem , Portugal,* [5]*European Space Agency, Noordwijk, The Netherlands*
62	Peculiarities of changes in the surface of cover glass exposed to electrons and protons with energies up to 40 keV	Prof. Lev S. Novikov[1], Dr. Rashid H. Khasanshin[2,3] [1]*Lomonosov Moscow State University, Moscow , Russian Federation,* [2]*JSC "Kompozit", Korolev, Russian Federation,* [3]*Moscow State Technical University, Moscow, Russian Federation*

63	Photocatalytic Activity of ZrO2 in Vacuum for Contamination Control of Spacecrafts	Dr. Naoki Shimosako[1], Prof. Hiroshi Sakama[2], Prof. Tadayasu Dotani[1] [1]*Jaxa, 3-1-1 Yoshino-dai, Chuo-ku, Sagamihara, Japan,* [2]*Sophia University, 7-1 Kioi-cho, Chiyoda-ku, Japan*
64	Planetary dust contamination, effects and mitigation	Ms. Alice Suarez Kahan[1], Bruno Bras, Bruno Delacourt, Julien Eck, Małgorzata Hołyńska, Cathal Mooney, Mauricio Portaluppi, Szilvia Szmolka, Sarah Rodriguez, Riccardo Rampini, Adrian Tighe [1]*ESA-ESTEC, Noordwijk, Netherlands*
65	POSS Polyimide Sealed Flexible Triple-Junction GaAs Thin-Film Solar Cells for Space Applications	Ms Min Qian[1], Ms Min Wu[2] [1]*East China University of Science and Technology, Shanghai, China,* [2]*Shanghai Institute of Space Power-Sources, Shanghai, China*
66	Protecting CFRP from ATOX damage with Acktar coating	Ms. Mila Berezanski[1], Ms. Dina Katsir[1], Ms. Irene Katsnelson[1] [1]*Acktar, Kiryat Gat, Israel*

67	Protective coatings for Tubular Booms - tests and qualification	Kamil Bochra[1,2], Dr. Maciej Ossowski[1,2], Prof Jerzy Sobiecki[1], Dr. Andrzej Czyzniewski[3], Eng Marta Tokarz[2] [1]*Warsaw University of Technology, Faculty of Materials Science and Engineering, Warsaw, Poland*, [2]*Astronika sp. z o.o., Warsaw, Poland*, [3]*Koszalin University of Technology, Faculty of Technology and Education, Koszalin, Poland*
68	Pulsed Electroacoustic Measurements of Polymers Irradiated with Low Energy Monoenergetic Electrons	Mr. Zachary Gibson[1], Professor JR Dennison[1] [1]*Utah State University, Logan , United States*
69	Reaction amount evaluation of fluoroalkyl and alkyl POSS with atomic oxygen	Mr. Kazuki Yukumatsu[1], Ms. Aki Goto[1], Dr. Soichi Yokoyama[2], Dr. Yutaka Ie[2], Dr. Yugo Kimoto[1] [1]*Jaxa, Tsukuba, Ibaraki, Japan*, [2]*Osaka University, Ibaraki, Osaka, Japan*
70	Reactive Molecular Dynamics Simulations on the Disintegration of Kapton and Upilex-S type polyimide during Atomic Oxygen Impact	Dr. Qiao Shiying[1] [1]*Beijing Institute Of Spacecraft Environment Engineerint, Beijing, China*

71	Regolith Block Microstrip Patch Antenna by In-situ coating technology on the Moon	Dr. Ayaka Takahashi[1], Jun Akedo[2], Josaphat Tetuko Sri Sumantyo[3] [1]*Teikyo University, Utsunomiya , Japan,* [2]*Agency of Industrial Science and Technology, Tsukuba, Japan,* [3]*Centre for Environmental Remote Sensing Chiba University, Chiba, Japan*
72	RESULTS OF CONTAMINANT DEPOSITION MEASUREMENTS ON POISK MODULE OF THE RUSSIAN SEGMENT OF THE INTERNATIONAL SPACE STATION	Dr. Andrey Krylov[1], Eng. Aleksandr Skorovarov[1] [1]*RSC "Energia", Korolev, Russian Federation*
73	Review on ZERODUR® compaction law	Dr. Antoine Carré[1], Dr. Rule Kirchhoff[1], Dr. Janina Krieg[1], Dr. Ralf Jedamzik[1], Dr. Thomas Westerhoff[1], Tony Hull[2] [1]*Schott AG, Mainz, Germany,* [2]*University of New Mexico, Albuquerque, United States*
74	Shielding effect of atomic oxygen by satellite structure observed on SLATS and its compensation for material exposure experiment	Dr. Masahito Tagawa[1], Mrs Kumiko Yokota[1], Mr. Wataru Ide[1], Mr. Atsushi Fujita[1], Mr Shohei Urakawa[1], Mr Yuta Tsuchiya[2], Mrs Aki Goto[2], Mr. Kazuki Yukumatsu[2], Dr. Eiji Miyazaki[2], Dr. Yugo Kimoto[2] [1]*Kobe University, Kobe, Japan,* [2]*JAXA, Tsukuba, Japan*

75	Smart heater based in flexible and adaptable electronics for future spacecrafts	Dr. Borja Pozo[1], Lorena Machón[1], David Cantero[1], Iñigo Muñoz[1] [1]*Tekniker, Eibar, Spain*
76	Solar Absorptivity Degradation of Spacecraft Materials Due to UV and Charged Particles in the Gateway Environment	Ms. Abigail Zinecker[1], Ms. Brittany Spivey[1], Mr. Griffin Jayne[2], Mr. Mark Hasegawa[2] [1]*NASA Johnson Space Center - Jacobs, Houston, United States,* [2]*Goddard Space Flight Center, Greenbelt, United States*
77	Sputtered Au coatings for space-based applications	Dr. Stefan Schwinde[1], Tim Zwerenz[1], Dr. Jochen Kuhnhenn[2], Michael Steffens[2], Dr. Alessandro Maturilli[3], Svetlana Shestaeva[1], Dr. Sven Schröder[1] [1]*Fraunhofer Institute for Applied Optics and Precision Engineering IOF, 07745 Jena, Germany,* [2]*Fraunhofer Institute for Technological Trend Analysis INT, 53879 Euskirchen, Germany,* [3]*Deutsches Zentrum fuer Luft- und Raumfahrt DLR, 12489 Berlin , Germany*

78	Strategy and facilities used to study envelope materials for stratospheric balloons	Dr. Simon Lewandowski[1], Stéphane Granier[1], Dr. Mikael Planes[2], Dr. Pascale Guigue[2] [1]*Onera, Toulouse, France,* [2]*CNES, Toulouse, France*
79	The Complex Irradiation Facility (CIF) at DLR Bremen	Thomas Renger[1], Dr. Maciej Sznajder[1], Dr. Peter Spietz[1], Dr. Patric Seefeldt[1], Eng. Erik Klein[1,2], Mr. Andreas Witzke[1] [1]*DLR Institute of Space Systems, Bremen, Germany,* [2]*University Bremen, Bremen, Germany*
80	The Design, Development and Application of the ESA REACH Tool - A Digital Materials Obsolescence Management tool A live demonstration of the database is also planned in the poster hall	Mr. Oliver Reiff-musgrove[1], Ms Laura Feasey[1], Mr Jorge Sanchez Seijo[2], Mr Premysl Janik[2] [1]*REACHLaw Ltd, Espoo, Finland,* [2]*ESA, Noordwijk, The Netherlands*

81	The Effect of POSS Type on the Shape Memory Properties and Space Environment Durability of Epoxy-Based Nanocomposites	Avraham Israel Bram[1,2,3], Irina Gouzman[2], Asaf Bolker[2], Nurit Atar[2], Noam Eliaz[1], Ronen Verker[2] [1]*Department of Materials Science and Engineering, Tel-Aviv University, Tel Aviv 6997801, Israel,* [2]*Space Environment Department, Soreq Nuclear Research Center, Yavne 81800, Israel,* [3]*Licensing & Safety Office, Israel Atomic Energy Commission, Tel Aviv, Israel*
82	The Electromagnetic Levitator on the International Space Station: Precise thermophysical property measurement of molten alloys	Dr. Markus Mohr[1], Dr. Yue Dong[1], Prof. Dr. Hans-Jörg Fecht[1] [1]*Ulm University, Ulm, Germany*
83	Thermal absorptivity of a metallic surface contaminated by EAC-1A regolith simulant	Authors: Tomas Kralik1(*), Jiri Frolec1, Bruno Bras[2], Mauricio Portaluppi[2] [1]*Institute of Scientific Instruments of the Czech Academy of Sciences, Kralovopolska, Brno (Czech Republic)* [2]*ESA-ESTEC, Netherlands*

84	Thermo-catalytic degradation of PFPE lubricants for space applications	Milena Gleirscher[1], Dr. Archim Wolfberger[1], Dr. Sandra Schlögl[1], Dr. Andreas Hausberger[1], Eric Helfer[1], Dr. Gernot Oreski, Dr. Małgorzata Hołyńska[2] [1]*Polymer Competence Center Leoben GmbH, Leoben, Austria,* [2]*ESA-ESTEC, Netherlands*
85	Towards DUSTFLOW - Particulate Contamination Flow Simulator	Armen Jaworski, Mr. Bruno Bras
86	Trial Experiment of Mass Gain Behaviour on Pristine Kapton Film after Heating in Vacuum	Mr. Eijo Fujiwara[1], Dr. Minoru Iwata[1], Dr. Masahito Tagawa[2], Dr. Sumitaka Tachikawa[3] [1]*Kyushu Institute Of Technology, Kitakyushu-shi, Japan,* [2]*Kobe University, Kobe, Japan,* [3]*Japan Aerospace Exploration Agency, Sagamihara, Japan*
87	Ultra-hydrophobic optical coatings as a means to lower outgassing	Ms. Dina Katsir[1], Ms. Irene Katsnelson[1] [1]*Acktar, Kiryat Gat, Israel*

88	Use of Remote Means for Inspections of Suppliers and Equipment for Space Applications	Ms. Alicia Garcia[1], Dr Sarah Jahn[2], Mr Roberto Zafra Yubero[3] [1]*Airbus Defence and Space SAS, Toulouse, France,* [2]*Airbus Defence and Space GmbH, Friedrichshafen, Germany,* [3]*Airbus Defence and Space S.A.U, Seville, Spain*
89	Using a portable IR spectrometer for materials characterization and identification	Miss Szilvia Szmolka[1], Mr Bruno Bras[1], Mr Orcun Ergincan[1], Mr Tim Nachtergaele[1], Mr Riccardo Rampini[1] [1]*European Space Agency ESTEC, TECQEE, Noordwijk, Netherlands*
90	Virtual Lab: the digitalization of qualification testing laboratory	Dr. Mari Carmen López[1], Mr Juan Carlos Hidalgo[1], Mr. Manuel Dominguez[1] [1]*Alter Technology, Sevilla, Spain*
91	White Kapton Evaluation for Space Applications	Mr. Carlos B. Mangas[1], Mr. Ignacio Melendo[1], Mr. Javier Yebrín[1], Mr. Carlos Montesano[1], Mr. Tim Scott[2], Mr. James Grieser[3] [1]*Airbus Defence & Space, Madrid, Spain,* [2]*DuPont de Nemours , Durham, USA,* [3]*Astral Technology Unlimited, Inc., Northfield, USA*

ROUND TABLE DISCUSSIONS:

Your chance to question the materials experts!

Moderated by: SPACE TECH EXPO EUROPE Smartershows A Tarsus Company

Location: Main conference hall

Date & Time: Wednesday September 21, 14:00 - 17:00

Join us in these three interactive roundtable discussions, where material experts will discuss some of the key challenges the space materials supply chain and research organisations are experiencing at the moment. This is your chance to share your burning questions with our expert set of speakers!

Today's roundtables:

- Roundtable 1: New Space, changing space - benefits and challenges for the spacecraft materials community
- Roundtable 2: Future proofing spacecraft manufacture - moving towards a more sustainable materials supply chain
- Roundtable 3: Dealing with dust contamination - are we ready to return to the Moon?

For each roundtable, there will be a general moderator from Smarter Shows (Tarsus) Ltd Space Tech Expo Europe, a roundtable chair and several panel experts.

Each discussion will last 45 minutes in duration and will be conducted according to the following format:

- The general moderator will introduce the topic and the panel members
- The panel chair will briefly summarise the technical background of the topic and initiate the discussion with the other experts
- The moderator will invite questions from the conference delegates

The success of the roundtables depends on the active contribution of the conference delegates. Please prepare your questions to the experts in advance!

Further details on the technical content for each panel and the internet site which you can use to ask the question is given on the following pages

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3. Once on the website, you will have the option to ask a question to the panel

Top tips

- Ask questions early in the session to be in with a greater chance of having your question asked by the moderator to the panellists
- Don't forget to vote for your favourite question and get it answered by the panel members

GENERAL MODERATOR:

Nicole Heins - Senior Conference Producer, Space Tech Expo Europe Smarter Shows (Tarsus) Ltd

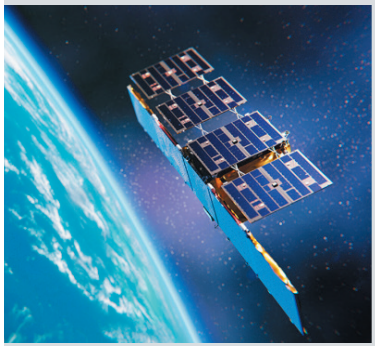
Nicole is Senior Conference Producer at Smarter Shows (Tarsus) Ltd. She has been working on the Space Tech Expo USA and Space Tech Expo Europe conferences for more than five years and has extensive knowledge of the global space technology industry and its downstream applications. She has also worked on other events including the Mobility Connectivity Conference, and the Satellite and Onboard Connectivity Summits. Nicole holds a BA degree in Journalism. She has a passion for space, hiking, trail running and mountain biking.

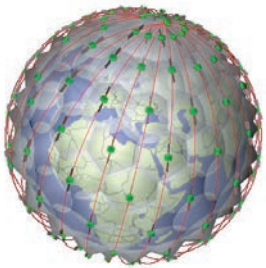
ROUNDTABLE 1: NEW SPACE, CHANGING SPACE - BENEFITS AND CHALLENGES FOR THE SPACECRAFT MATERIALS COMMUNITY

The space industry is undergoing rapid change. New commercial players are entering the market and providing cheaper routes to orbit, and new methodologies are being used to decrease hardware development time. This is the so-called New Space age.

On a global scale some changes are quite evident. For example, constellations of miniature satellites are replacing single larger spacecraft, with reliability and longevity sacrificed for lower development costs and turn around time to orbit. Smaller enterprises and start up companies are taking advantage of the opportunities and entering the market, which was once the domain of a select few space agencies and larger industries.
Join in the conversation and pose your question to our speakers! This roundtable will address key points regarding NewSpace and the materials community, including:

- How does the spacecraft materials community adapt to these changes, when historically the emphasis has been on developing more advanced materials and improving robustness of materials to the space environment?
- How can so-called commercial materials have an increased use in spacecraft design?
- How can we relax requirements on fundamental properties such as outgassing or environmental resistance for lower reliability missions?
- What risks can be taken at materials level to improve product turn-around time?
- Are spacecraft materials currently over-engineered?
- Is the 'test as you fly' adage becoming obsolete?





Panel Chair: **Kristiina Jokela** (Aurora propulsion technologies, Finland)
Kristiina Jokela started her career in space at ESA-ESTEC (NL) as a young graduate trainee in 2001 in Chemical Propulsion. Since then she has worked as Materials and Process Engineer at ESA-ESTEC (NL), Product Assurance Engineer and Manager at RUAG Space (CH) and Product Assurance Manager at Inmarsat (FR). She is currently a PA and QA Manager at Aurora Propulsion Technologies (FIN). Her expertise is Materials, Processes and EEE components assurance, as well as Product Assurance and Quality Assurance Management. She has a MSc in Materials Chemistry and MBA in General Management.

Panel Members: **Deborah Mueller** (RUAG Zurich, Switzerland)

ROUNDTABLE 2: FUTURE-PROOFING SPACECRAFT MANUFACTURE - MOVING TOWARDS A MORE SUSTAINABLE MATERIALS SUPPLY CHAIN

A key focus of the conference is the development of new materials and manufacturing processes which will make spacecraft more robust against degradation to the space environment. However, these efforts are in vain if we do not have a sustainable materials supply chain for future spacecraft manufacture. Threats to global supply chains are currently severe, on the back of the COVID-19 pandemic, global conflict and the increasing impact of man-made environmental damage and climate change. There will inevitably be short- and long-term impact on procurement of high performance materials and the implementation of the advanced industrial processes used in spacecraft manufacture. In the future, there will be an increasing need to comply with new environmental regulations and to find replacements for obsolete, rare or unethically sourced materials.

As you formulate your questions to the panel, the roundtable will kick off with a brief discussion surrounding the following questions:

- How can the spacecraft industry anticipate and adapt to these changes?
- How can turn around times be improved for development and validation of new materials?
- How do we identify and minimise obsolescence risks?
- Are we too reliant on single source procurement of advanced materials?
- How do we move towards a more sustainable materials supply chain for future manufacture of spacecraft?

Panel Chair: **Premysl Janik** (ESA)
Premysl Janik obtained his MSc and PhD degree at the Institute of Chemical Technology in Prague (Czech Republic). Since 2014, he has been working at the European Space AgencyESTEC Netherlands as a Materials and Processes engineer, specifically focusing on adhesive bonding technologies. He participated in the working group responsible for development of the ECSS standard for adhesive bonding processes for spacecraft and launcher applications. Since 2020, he is the ESA REACH Officer and supports the Agency in the matters of regulations of chemicals, material formulationprocess changes and other topics potentially triggering obsolescence issues. Currently he is also the chair of the Materials & Processes Technology Board (MPTB), where he deals with the obsolescence-related topics on sectorial level.

Panel Members: **Christian Puig** (Airbus, France), **Paola Bruno** (OHB, Germany), **Elisabeth Laurent** (CNES)

ROUNDTABLE 3: DEALING WITH DUST CONTAMINATION - ARE WE READY TO RETURN TO THE MOON?

Since the early days of the Apollo missions, the problem of dust contamination is well known, as recalled in one of the famous quotes from Eugene Cernan, commander of Apollo 17: “One of the most aggravating, restricting facets of lunar surface exploration is the dust and its adherence to everything no matter what kind of material, whether it be skin, suit material, metal, no matter what it be and it’s restrictive friction-like action to everything it gets on”.

The Apollo astronauts dealt with dust as best as they could for these relatively short duration missions with limited exposure on the lunar surface. Yet now, decades later, space agencies and commercial organisations have plans for much longer duration missions to the Moon, with extended stays on the surface, as well as orbiting spacecraft and surface transfer flights. There are also more far-reaching plans to establish permanent bases on the Moon and to construct hardware which can utilise the lunar soil as a natural resource.

This roundtable explores our current state of knowledge on the effects of lunar dust contamination on space hardware. Make sure to prepare your questions to our panel - in the meantime we will kick off the conversation with the following topics:

- What have we learnt from Apollo?
- Do we fully understand the long term effects of lunar dust?
- How do we simulate the lunar environment and perform ground based testing?
- How do we take into account the effects of dust in spacecraft design?
- Are we ready to return to the Moon?

Panel Chair: **James Gaier** (NASA, retired)
Jim Gaier holds a B.S. from Manchester College in Chemistry, an M.Ed. From Temple University in Secondary Education, and a Ph.D. from Michigan State University in Physical Chemistry. He taught High School for 3 years, and College for 15 years. He spent 35 years at the NASA Glenn Research Center as a Research Physicist in the Electro-Physics Branch and its subsequent incarnations. The focus of his work was the protection of spacecraft systems from the effects of space environments including those of low Earth orbit and the dusty surfaces of the Moon, Mars, and asteroids. His approach has been a combination of scouring historical records and building up environmental test chambers, such as the Lunar Dust Adhesion Belljar, in which he tested model components. He has published nearly 200 unique articles including NASA Reports, conference and workshop presentations, and refereed journals.

Panel Members: **Jacob Kleiman** (ITL, Canada), **Antonio Severino** (Thales Alenia Space, Italy), **Jean-Charles Mateo-Velez** (ONERA)

ADDITIONAL INFORMATION

EXHIBITION

- The exhibition is an ideal opportunity to connect with potential customers and collaborators. It will be located on the balcony area above the main auditorium.
- The exhibition will be open for the duration of the conference, and exhibitors are strongly recommended to be present in the exhibition area during coffee breaks and / or poster presentations.

INFORMATION FOR ORAL PRESENTERS

- All presenters are requested to meet the chairs of their oral session, 15 minutes before it begins.
- Presenters shall check that their presentation has been properly loaded on the PC of the conference room. There will be assistance available. Please do not leave this until the last minute (it can be done during any of the breaks or at the startend of the days).
- Presenters will not be allowed to use their own laptop.
- Presenters at the oral sessions will have **20 minutes** to present their paper which includes time for questions and discussions. A reminder will be given at 15 minutes. As a courtesy to the other presenters, please adhere strictly to these timings.
- Presenters of *HighLight Talks* at the oral sessions will have **30 minutes** to present their paper, which includes time for questions and discussions. A reminder will be given at 25 minutes. As a courtesy to the other presenters, please adhere strictly to these timings.

INFORMATION FOR SESSION CHAIRS

- The session chairs should arrive in the hall at least 15 minutes prior to the start of the session.
- They shall ensure that all presenters are present.
- One of the two chairs shall shortly introduce the presenter
- The chairs share the task of keeping control of the session and presentations timing. A reminder shall be given at 15 minutes for talks of standard length and at 25 minutes for highlight talks.

DIGITAL ARCHIVE OF POSTERS AND PRESENTATIONS

- A digital archive of posters and oral presentations from the conference will be downloadable from the conference website for a limited time after the conference
- This archive does not replace the conference proceedings (see following page)
- If you wish to have a digital version of your poster or oral presentation included in the archive, please email it in **pdf format** to the following address by 17:00 on Friday 23rd September (close of the conference): esaconferencebureau@atpi.com
- It is the responsibility of the author(s) to ensure that the files are authorised for release and do not include any confidentialproprietary information
- The files will not be reviewed for technical accuracy. Files not in pdf format will be rejected. Maximum allowed file size is 25MB. Late upload of files will not be accepted.
- The link to download the digital archive will be available on the conference website by end September 2022. The archive will be accessible for a period of 6 months.
- The digital archive is provided as a courtesy to registered conference participants. The conference organisers cannot be held responsible for any inaccuracies in the content of the papers.

CONFERENCE PROCEEDINGS

- Authors are invited to submit papers for the ISMSE-15 ICPMSE-13 conference proceedings which will be published as Open Access in IOP Conference Series: Materials Science and Engineering.
- Papers will undergo a peer review process administered by the ISMSE ICPMSE conference proceedings editorial board.
- The review process will assess the scientific content, quality and presentation of the papers and the decision of the editorial board will be final. Papers need to contain significant and original materials science and engineering content, which falls within the scope of the conference. Authors are also encouraged to use feedback received during the conference to improve the content of the papers.
- Papers based on both oral and poster presentations can be proposed for publication, provided the author has attended the conference (no distinction between paper types will be made in the proceedings, and the same review criteria will apply).
- Papers will be published as Open Access under the terms of the Creative Commons Attribution (CC BY) licence.
- Further information about the copyright license, the review process and requirements for the paper format can be found at https://publishingsupport.iopscience.iop.org/author-guidelines-for-conference-proceedings/
- The submission process will be handled using the IOP proceedings management platform via the following link: https://www.morressier.com/call-for-papers/6241846f366c7e00129288f4
- Deadline for paper submission is 31st October 2022, with acceptance notification by end February 2023.
- The conference proceedings editorial board also invites conference attendees with relevant expertise to participate in the peer review process.
- Please contact the chair of the editorial board for further information: malgorzata.holynska@esa.int

SOCIAL PROGRAMME

MONDAY 19TH SEPTEMBER (EARLY EVENING)

- Welcome reception in the Naturalis Biodiversity Centre, sponsored by Integrity Testing Laboratory (ITL inc), Ontario, Canada.
- An opportunity to network with other conference delegates within the fantastic surroundings of the "glass crown" area of the Naturalis museum. Cheese, wine, beer and other snacks will be served.

WEDNESDAY 21ST SEPTEMBER (EVENING)

- Conference Gala dinner at the Louwman Museum, in The Hague, Netherlands, hosting historic cars, coaches, and motorcycles. A short tour of the museum is included before the dinner.
- Bus transport to / from Leiden to the venue will be provided. Departure will take place from Naturalis at 18:15. Departure from Louwman Museum at 22.30 (approximately)
  Address: Louwman Museum, Leidsestraatweg 57, 2594BB Den Haag
- **Traveling by public transport**
  The name of the bus stop is Louwman Museum, bus 386 stops here. The bus stop is in front of the Louwman Museum. Plan your journey: www.9292ov.nl
- **Travelling by car**
  On the A4 take the A44 in the direction of 'Leiden-WestDen Haag centrum'. The A44 becomes the N44, continue in the direction of Wassenaar-Zuid Den Haag. Continue on the N44. The road passes under the N14. Turn left at the first set of traffic lights (800 m) and left again immediately after the lights. You are now on the Louwman Museum access road.

- **Parking**

  The Louwman Museum has an underground car park. The total capacity is 170 cars. Parking costs € 7.
- **Disabled visitors**

  Disabled visitors may park free of charge near the main entrance to the museum. To get there, drive down the footpath that runs in front of the museum. There is no access or lift from the underground car park for disabled visitors.
- **Showpieces over 40 years of age**

  Motor vehicles over 40 years old may be parked free of charge on the square at the front of the museum. Drive down the footpath in front of the museum to get there.

TECHNICAL VISITS

There are three different tours planned, which will all take place in parallel on Friday, 23rd September 2022 from 14:00 to 16:30. There will be a shuttle organized for those facilities which are not available to access by foot. There is also a return shuttle planned, which will bring you back to Naturalis after the tour.

The three different venues are:

- Airbus Leiden TGL building (solar array assembly)
- Airbus Nebula building (Launcher structures assembly)
- ESTEC Materials and Electrical Components Laboratories

For the tours to Airbus locations, the agenda is as follows:

- 14:30-15:00 Plenary company presentation by Bas Wolschrijn, Director Programmes at Airbus NL – location: Naturalis
- 15:00-16:00: Group visits to TGL and Nebula buildings
- 16:00 Drinks at Airbus Leiden (Mendelweg 30)

About Airbus solar array cleanroom:

At the cleanroom in Leiden, Airbus Netherlands assembles and tests solar arrays to satisfy the extremely strict design requirements associated with spaceflight. Lightweight, exceptionally reliable and sufficiently robust to survive a rocket launch. Airbus NL produces solar arrays to order for commercial and institutional clients. To name a few missions: Sentinel 1 and 2, JUICE, BepiColombo, Solar Orbiter and Orion ESM.

About Airbus Nebula:

The Nebula building of Airbus NL is a 5,000 sqm smart factory, equipped with industry 4.0 capabilities, where the engine frames for the lower and upper propulsion module of the Ariane 6 launcher and the Interstage 1/2 of Vega-C are being developed, built, tested and qualified.

About ESTEC Materials and Electrical Components Laboratories:

Made up of more than 20 dedicated experimental facilities and hundreds of instruments overall, the Materials & Electrical Components Laboratory guarantees an optimal choice of electrical components, materials and processes for ESA missions and external projects. This is accomplished by considering the unique environmental challenges involved in building for space, and, additionally, investigating failures to ensure that similar issues do not occur on future missions. Physical and chemical properties of all materials within a spacecraft are routinely characterized verifying and qualifying their use. The laboratory, with its team of highly trained engineers, is ISO 9001 certified, and its Co-60 radiation facility is accredited to ISO/IEC 17025. Additionally, it serves as a certification authority for space materials and processes (M&P) in Europe. It provides impartial and independent testing and expert knowledge achieved using the unique equipment support service made possible at ESA-ESTEC.

SHORT COURSE

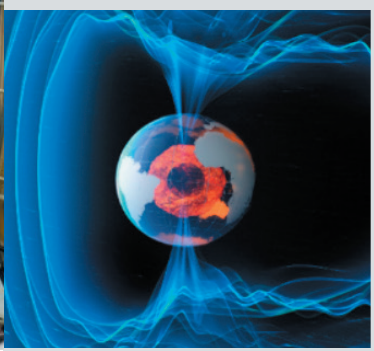
SUNDAY 18TH SEPTEMBER 2022, ESA - ESTEC

12:00 - 13:00 **Entry to ESTEC, light refreshments and welcome**

13:00 - 13:40 OVERVIEW OF THE SPACE ENVIRONMENT AND ITS IMPACT ON MATERIALS

Adrian Tighe *(European Space Agency, ESTEC, The Netherlands)*

The lecture will describe how materials behave in the space environment, highlighting the unique risks compared to terrestrial applications. Examples of common materials used for typical space applications and the associated space environmental effects will be provided, together with some real life examples of investigations from ESA's space projects. The role of the materials engineer within the space product assurance discipline will be described, to highlight the tasks required in order to demonstrate the compatibility of the materials with the space environment and to ensure that the materials remain fit for purpose for the lifetime of the mission. An introduction will be provided to the main space standards.



13:40 - 14:20 NEUTRAL ENVIRONMENT: ATOMIC OXYGEN AND DRAG EFFECTS IN LEO AND VLEO

Timothy Minton *(University of Colorado, Boulder, USA)*

Atomic oxygen (AO) interactions with surfaces on satellites in low Earth orbit (LEO) can degrade the function of materials through reactions that result in erosion (ablation) and oxidation. As orbital altitude decreases, the exponential rise in atmospheric density increases the AO, as well as the N2, flux on satellite surfaces, increasing the AO hazard and adding the challenge of drag if a satellite is to operate in very low Earth orbit (VLEO). The exposure of materials in a LEO or VLEO environment can provide important phenomenological data on the performance of these materials in a specific environment. Still, ground-based testing can provide performance data at lower cost, and laboratory experiments can illuminate the relevant chemical and physical interactions when AO andor N2 bombards a surface, thus providing information to guide the development of space-durable materials and the prediction of their behavior in a particular environment. This lecture will review the important gas-surface interactions that may affect satellite operation in LEOVLEO environments, as well as approaches to mitigate the effects of these interactions. In addition, considerations for informative ground-based testing and relevant laboratory experiments will be discussed.

14:20 - 15:00 COMBINED EFFECTS OF THE INDUCED AND NATURAL ENVIRONMENTS

Irina Gouzman *(Soreq NRC, Israel)*

The lecture will highlight many of the different synergistic effects which can occur in the space environment, including UV and AO effects on contaminant deposits, photofixationphotpolymerization, degradation of thermo-optical properties of materials, radiation induced outgassing

15:00 - 15:30 **Coffee break**

15:30 - 16:30 CONTAMINATION CONTROL IN SPACE PROJECTS

Carlos Soares *(NASA Jet Propulsion Laboratory, USA)*

The lecture will cover the fundamental principles of cleanliness and contamination control for space projects. This will include:

- Desorption, diffusion and adsorption
- Modeling & analysis: Fick's laws of diffusion, the Arrhenius equatio
- Analytical techniques and measurements: ASTM E 595, ASTM E 1559, Multi-species modeling
- Importance and lessons learned (failures caused by outgassing induced contamination)
- Fabrication, cleanroom operations, thermal-vacuum, I&T, ATLO]
- Particulate generation (materials, during flight)
- Plume induced contamination and erosion effects (bipropellant, monopropellant, electric propulsion)
- Plume models

16.30 - 17.15 RADIATION AND CHARGING EFFECTS ON MATERIALS

Sophie Duzellier and Thierry Paulmier *(The French Aerospace Lab, ONERA, France)*

In orbit materials are fully exposed to radiations due to absence of shielding i.e. paints on radiators and thin films of MLI, coatings, solar cells assemblies ..., all embedded in critical sub-systems (thermal control, optics, power generation). Among the large variety of materials, polymers are known to be prone to ionizing radiation and ageing mechanisms. Consequently, the physico-chemical properties are affected by radiation and thus the thermo-optical, electrical and mechanical performance.

Charging process can also be hazardous for the satellite systems: the high potential differences initiated between the adjacent and neighbour space elements may induce electrostatic (ESD) and arc discharges on the satellite. Electric behavior of polymers can actually be noticeably altered through high radiation dose effect.

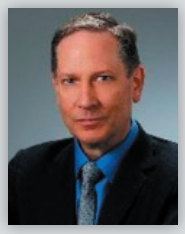
Space mission profiles are also diversifying and for instance, Electric Orbit Raising (EOR) orbits imply a prolonged exposure to electrons and protons in radiation belts (and thus higher dose and energies encountered)

This lecture will provide a description of the radiation and plasma environments, as well as covering fundamental principles of particlematter interactions leading to effects on materials. Ageing and charging mechanisms will be illustrated by study cases showing the main risks for spacecraft. Lastly, an overview of ground based testing techniques will highlight the criticality of representativeness of ground experiments.

17.15 - 18.00 CLOSING REMARKS, QUESTIONS AND PRE-REGISTRATION FOR THE ISMSE CONFERENCE

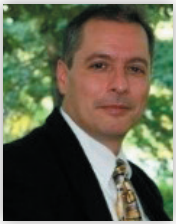
BIOGRAPHIES OF SHORT COURSE SPEAKERS

Adrian Tighe is a Senior Materials Engineer in the Directorate of Technology, Engineering and Quality at the European Space Agency in ESTEC, where he has worked since 2001. He supports ESA space projects and works with ESA's industrial partners on all issues related to the effects of the space environment on materials and coatings, with the direct involvement of ESA's materials and components test laboratories. Recently, he has worked for ESA's Aeolus mission on issues related to laser induced contamination and damage of the optical components, and the Bepi Colombo mission, where he tackled issues related to the compatibility of materials with the harsh Mercury environment. Before joining ESA, he obtained his Ph.D. and held a postdoctoral research fellowship at the University of Southampton, UK, performing research into the effects of high velocity space debris particle impacts on materials.



Timothy K. Minton is a professor in the Ann and H.J. Smead Department of Aerospace Engineering Sciences at the University of Colorado. He earned his B.S. in Chemistry from the Univ. of Illinois in 1980 and his Ph.D. in Chemistry from UC Berkeley in 1986. Following two post-doctoral positions, at the Univ. of Illinois and at the Univ. of Zürich, Switzerland, he became a Member of Technical Staff at the Jet Propulsion Laboratory in Pasadena, CA in 1989. In 1995, he joined the faculty at Montana State University, Dept. of Chemistry and Biochemistry, from which he transferred to the University of Colorado in the Summer of 2020. He is a Fellow of the American Chemical Society, the American Physical Society, and the American Association for the Advancement of Science, and he is an Associate Fellow of the American Institute of Aeronautics and Astronautics. His current research projects include studies of gas-phase and gas-surface energy transfer and reactions, including boundary layer chemistry in shock layers on hypersonic vehicles, oxidation and decomposition of heat-shield materials, the detection of gases in rarefied planetary atmospheres, satellite drag, and the development of new and more durable materials for use on spacecraft in low Earth orbit.

Irina Gouzman received her Ph.D. in Physical Chemistry in 1999 from the Technion - Israel Institute of Technology in Haifa. After receiving her PhD degree, she jointed Soreq NRC where she is working on the effects of space environment on materials durability. Her research interests are in the areas of applied surface science and materials characterization by a variety of electron microscopy and spectroscopy techniques. In 2022-2021 she spent her sabbatical at Prof. Timothy K. Minton's Lab, Department of Aerospace Engineering Sciences, at University of Colorado, Boulder, focusing on atomic oxygen interaction with polymers. Currently, she is the head of the Space Environment Department at Soreq NRC.



Carlos Soares is a Principal Engineer with the NASA Jet Propulsion Laboratory (JPL) and the Technical Group Supervisor for Contamination Control Engineering in the Mechanical Systems Division. His primary research areas are thruster plume effects, materials outgassing, contaminant transport, molecular gas dynamics, surface and materials science, optical and thermo-optical property degradation, and space environments and effects. His current projects include Mars 2020, Europa Clipper, Mars Sample Return, Lunar Gateway and Human Landing Systems, and Europa and Enceladus Lander Advanced Technology Development. Past projects include Space Shuttle and International Space Station programs. Carlos received his B.S. in Aerospace and Ocean Engineering from the Virginia Polytechnic Institute and State University and his M.S. from the OU, followed by research in Computational Fluid Dynamics and Propulsion at the NASA Center for Space Propulsion Engineering at Penn State University.

Thierry Paulmier received his Engineer degree in material physics in 1996 from Grenoble Institute of Technology and the Ph.D. degree in materials physics and instrumentation in 2000 from the University of Toulouse. He is currently Research Director at the Physics Instrumentation and Space Department of ONERA since 2007. He is involved in experimental and theoretical studies for the analysis of electrical charging and discharging effects on space materials. He currently manages technical and scientific studies performed in the ONERA irradiation facilities used for the simulation of electron spectra in GEO, MEO, LEO and planetary orbit and the characterisation of charging behaviour of space elements. His research activities are focused on charge transport mechanisms in dielectric and space materials, development of measurement techniques and test methods and on electrical ageing of space used polymers.

Sophie Duzellier is graduated from INSA Engineering School and obtained her Ph.D. degrees in microelectronics at Toulouse University. She joined ONERA in 1989 in the Space Environment department to address radiation effects in electronic devices. She is currently senior Materials Engineer in the DPHY department (Physics Instrumentation Environment Space) working on effect of Space environment on surface materials (thermal control, solar arrays) and developing flight experiments (PI of MEDET ISS-2009, RESISTACK in SESAME / EMA experiment for ISS-2023 mission...). She has recently worked on JUICE and EUROPA CLIPPER missions (radiation induced-ageing thematic, qualification) and supported Industry in development and ground testing of new materials and devices (thermo-chromic materials...). She is also performing research in the field of new generation of solar cells (Perovskite with CEA-Liten, IIIV technologies with LAAS), flexible polymer and silicone encapsulation (ONERA PhDs), Atomic Oxygen monitoring and effect, and radiation-synergy with contamination.

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