**Iron oxide based nanomaterials for diagnosis and treatment of cardiovascular disease**

*Hang T TaA,B*

AAustralian Institute for Bioengineering and Nanotechnology, the University of Queensland, Brisbane, Australia; BSchool of Pharmacy, the University of Queensland, Brisbane, Australia; Email: h.ta@uq.edu.au

The most common form of cardiovascular disease (CVD) and also the leading cause of sudden death is atherosclerosis, a chronic progressive inflammatory disease of the arterial vessels. Unstable, vulnerable atherosclerotic plaques can rupture and cause thrombosis, resulting in myocardial infarction (MI) and stroke. Magnetic resonance imaging (MRI) has been used as a powerful and indispensable tool in medical research and clinical diagnosis due to its high spatial resolution and non-limited penetration depth. We have developed both targeted negative contrast agents and targeted dual positive/negative contrast agents for molecular imaging of atherothrombosis1,2,3,4. The simultaneous use of positive and negative MRI imaging that employs the same contrast agents will significantly improve the detection accuracy. Using these dual contrast agent, both T1- and T2-weighted MRI of thrombosis can be recorded simultaneously which enables self-confirmation of images and leads to a greater diagnostic accuracy. We have also designed and developed smart MRI nano-sensors that can not only detect, but also sense and report the stage or progression of CVD such as thrombosis5. The early detection and accurate characterization of life-threatening diseases such as CVD and cancer are critical to the design of treatment. Knowing whether a thrombus in a blood vessel is new/fresh or old/constituted is very important for physicians to decide a treatment protocol. Theranostic nanoparticles based on iron oxide and cerium oxide have also been developed in our group as potential materials for diagnosis and treatment of reactive oxygen species related inflammatory diseases such as CVD6. Another class of theranostic nanoparticles based on iron oxide and silver with NIR absorption has also been synthesised as a potential material for the simultaneous detection and treatment of thrombosis.

**References**

1. Hang T. Ta, Sandeep Prabhu, Ephraem Leitner, Fu Jia, D. von Elverfeldt, K. Putnam, T. Heidt, A. Nair, H. Pearce, C. von zur Muhlen, X. Wang, K. Peter, C.E. Hagemeyer. 2011. Enzymatic Single-chain Antibody Tagging: A Universal Approach to Targeted Molecular Imaging and Cell Homing in Cardiovascular Disease. Circulation Research, 109, 365-373.
2. Christoph E. Hagemeyer, Karen Alt, Angus P. R. Johnston, Georgina K. Such, Hang T. Ta, Melissa K. M. Leung, Sandeep Prabhu, Xiaowei Wang, Frank Caruso, Karlheinz Peter. 2015. Particle Generation, Functionalization and Sortase A-mediated Modification with Targeting Antibodies for Diagnostic and Therapeutic Use. Nature Protocols, 10, 90-105.
3. Hang T. Ta\*, Zhen Li, Christoph E. Hagemeyer, Gary Cowin, Shaohua Zhang, Jathushan Palasubramaniam, Karen Alt, Xiaowei Wang, Karlheinz Peter, Andrew K. Whittaker. 2017. Molecular Imaging of Activated Platelets via Antibody-Targeted Ultra-small Iron Oxide Nanoparticles Displaying Unique Dual MRI Contrast. Biomaterials, 134, 31-42.
4. Hang T. Ta\*, Zhen Li, Yuao Wu, Gary Cowin, Shaohua Zhang, Anya Yago, Andrew K. Whittaker, Zhi Ping Xu. 2017. Effects of magnetic field strength and particle aggregation on relaxivity of ultra-small dual contrast iron oxide nanoparticles. Materials Research Express, 4, 116105.
5. Hang T. Ta\*, Nina Arndt, Yuao Wu, Hui Jean Lim, Shea Landeen, Run Zhang, Danielle Kamato, Peter J. Little, Andrew Whittaker, Zhi Ping Xu. 2018. Activatable Magnetic Resonance Nanosensor as a Potential Imaging Agent for Detecting and Discriminating Thrombosis. Nanoscale, 10, 15103-15115, Jif = 7.4.
6. Yuao Wu, Yanchen Yang, Wei Zhao, Zhi Ping Xu, Peter J. Little, Andrew K. Whittaker, Run Zhang, Hang T. Ta\*. 2018. Novel iron oxide-cerium oxide core-shell nanoparticle as a potential theranostic material for inflammatory diseases. Journal of Materials Chemistry B, 6, 4937-4951