



Chemeca2026
Innovate. Integrate. Impact.

28 – 30 September 2026
Melbourne, Australia



*Chemeca 2026 and Hazards Australasia
28 – 30 September, Melbourne, Australia*

Support-engineered Fe-based catalysts for selective transformation of 1,8-cineole into value-added chemicals

Diyasha Sengupta^{a,b}, Gil Garnier^{a,b}, Shanthi Priya Samudrala^{a,b}

^aDepartment of Chemical and Biological Engineering, Monash University, Australia

^bBioresource Processing Research Institute of Australia (BioPRIA), Monash University, Australia

Diyasha.sengupta@monash.edu

ABSTRACT

The catalytic upgrading of renewable terpene feedstocks offers a promising route toward sustainable chemical production. Among these, 1,8-cineole, the dominant component of eucalyptus oil, is an attractive bio-based platform molecule due to its abundance and cyclic ether structure. However, its catalytic transformation typically produces a wide range of products including terpineol, limonene, terpinene, terpinolene and p-cymene, making selective product formation challenging. Achieving precise control over product distribution therefore requires careful catalyst design, particularly in terms of acidity and active site characteristics. However, the influence of these parameters on the reaction pathways of 1,8-cineole remains insufficiently understood.

In our previous work, a Fe-Al₂O₃ catalyst enabled the selective production of limonene from 1,8-cineole under mild vapour-phase conditions, offering a more sustainable alternative to conventional energy-intensive synthesis routes and highlighting the critical role of catalyst acidity in directing the reaction. Building on these findings, this study investigates the role of catalyst support in Fe-based systems for the vapour-phase transformation of 1,8-cineole. A series of Fe-supported catalysts were synthesised on oxide and zeolitic supports including Fe-Al₂O₃, SiO₂-Al₂O₃, zeolite Y and mordenite with varying SiO₂/Al₂O₃ ratios to evaluate how support-induced variations in acidity and Fe dispersion influence reaction pathways and product selectivity. The catalysts were comprehensively characterised to elucidate the physico-chemical properties governing their catalytic performance.

The results demonstrate that support properties strongly influence Fe dispersion and the balance of Lewis and Bronsted acidic sites, thereby directing the dominant reaction pathway. Fe-Al₂O₃ favoured selective limonene formation, achieving 78% conversion with 81% limonene selectivity at 210°C under atmospheric pressure. Preliminary results obtained under mild reaction conditions showed that Fe catalysts supported on SiO₂-Al₂O₃ and zeolite Y with comparable SiO₂/Al₂O₃ ratios (~5:1) promote deeper dehydrogenation and aromatisation pathways, producing p-cymene as the major product with selectivity exceeding 60%. Under similar conditions, Fe-mordenite with the highest SiO₂/Al₂O₃ ratio (~20:1) selectively produced α-terpinene with ~50% selectivity. All three catalysts exhibited 1,8-cineole

conversions >95%. Comprehensive characterisation using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), NH₃ temperature-programmed desorption (NH₃-TPD), Brunauer-Emmett-Teller surface area analysis (BET) and X-ray photoelectron spectroscopy (XPS) revealed key information on Fe dispersion, metal-support interactions, catalyst structure and surface acidity, providing insights into the observed differences in catalytic performance and dominant reaction pathways.

Overall, this work demonstrates that rational support engineering can effectively steer the complex reaction network of 1,8-cineole transformation toward desired products. Considering the large availability of eucalyptus biomass in Australia, such catalytic strategies could enable the sustainable utilisation of locally abundant terpene resources for value-added chemical production.

KEY WORDS

Heterogeneous catalysis; Fe-based catalysts; Biomass valorisation; Eucalyptus-derived terpenes; Sustainable chemical production

BIOGRAPHY

Diyasha Sengupta is a PhD candidate in the Department of Chemical and Biological Engineering at Monash University, Australia. She holds a background in Chemical Engineering and her research focuses on heterogeneous catalysis for the sustainable upgrading of biomass-derived terpene feedstocks. Her work explores catalyst design, support engineering and reaction optimisation for the selective transformation of 1,8-cineole into value-added chemicals such as limonene and other monoterpenes. Her recent research published in the Journal of Materials Chemistry A was recognised as a 2026 Hot Paper, highlighting its impact on developing sustainable catalytic strategies for renewable chemical production.

CONFERENCE PROGRAM

Please indicate which conference program your abstract relates to:

Hazards Australasia

Chemeca