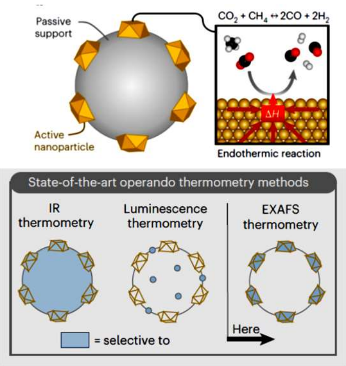
Groundbreaking Study Unveils Advanced Nanothermometry for In-situ Catalyst Monitoring



A research team from the Laboratory for Chemical Technology (LCT) at Ghent University, including Vladimir Galvita and Hilde Poelman, as well as former LCT members Matthias Filez and Valentijn De Coster, in collaboration with colleagues from the Faculty of Science, has made a significant breakthrough in catalytic reaction monitoring. They have pioneered a novel method for selectively measuring the temperature of active metal nanoparticles during chemical processes.

Their study, recently published in **Nature Catalysis**, introduces Extended X-ray Absorption Fine Structure (EXAFS) Thermometry, a cutting-edge technique that enables real-time, highly accurate temperature measurements at the nanoscale, https://www.nature.com/articles/s41929-025-01295-9.

The research demonstrates that during endothermic reactions, such as methane reforming, nickel nanoparticles act as localized “heat sinks”, experiencing temperature drops of up to 90°C compared to the reactor’s bulk temperature. Conversely, in exothermic reactions, like CO_2 methanation, the nanoparticles exhibit temperature rises. These findings challenge conventional assumptions that the catalyst temperature is uniform throughout a reactor and highlight the importance of precise temperature monitoring for catalytic process optimization.

The findings pave the way for next-generation catalyst design, with direct implications for reducing industrial carbon footprints and advancing clean energy technologies. In the near future, the researchers aim to extend this technology to a wider range of catalytic materials and integrate it with existing reactor monitoring systems to enhance real-time process control.

Congratulations to the authors and wishing them new success and achievements in science!

"Traditional thermometry methods often fail to capture the actual temperature of active catalytic sites, providing only an average reading of the surroundings. Our innovative EXAFS-based nanothermometry overcomes this limitation by directly isolating temperature fluctuations within individual nickel nanoparticles—key components in catalytic processes—and tracking their energy changes in real-time," first author **Matthias Filez** explains.

“XAS campaigns require a lot of organization and intense day and night work on the beamline. Seeing that collected data lead to this kind of publications makes it all worthwhile! In particular, it is surprising to see that the Debye-Waller factor, often regarded as a negative effect in data analysis, has been utilized in our approach to extract valuable information. By re-interpreting this factor, we have discovered a way to gain new insight that was previously overlooked," **Hilde Poelman** comments.

Vladimir Galvita: "While this research provides game-changing insights for catalyst design, we can’t help but joke that we have designed the world’s most expensive thermometer—costing over a billion euros, given the need for large-scale synchrotron facilities and advanced spectroscopic techniques." "It’s not exactly something you’d use to check your fever, but if you want to know the temperature of a single nanoparticle inside a working reactor, this is the way to do it," he adds with a smile.