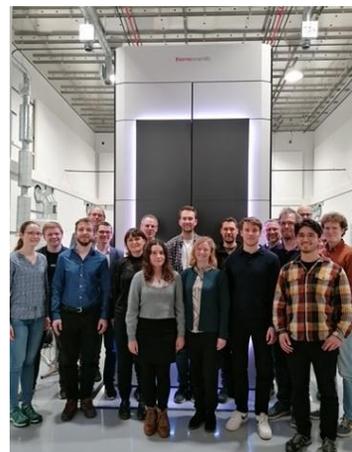


Annual highlights

VISION made significant breakthroughs in 2023. First, it was the year in which VISION established a new electron microscope that is unique in the world. It sets apart by enabling visualizations of the three-dimensional atomic structure of nanoscale materials as well as their dynamic behavior under chemical reaction conditions. These extremely sensitive measurements are key for solving one of the most challenging scientific questions in catalysis – namely, how do individual nanoscale particles catalyze chemical reactions?

The microscope was developed in collaboration with the manufacturer Thermo Fisher Scientific. As the first microscope ever, it combines new optical components and detectors to achieve the physically limited resolution of ~ 50 pm in the presence of chemically reactive environments. The microscope is installed in DTU's new Climate Challenge Laboratory to integrate the unique imaging capabilities in a vibrant, world-leading research environment and create the strongest interdisciplinary research synergies. The unique resolution of the microscope imposes extremely high demands on the environment, and the installation has only been successful because a highly advanced laboratory was built to shield the microscope against acoustic, vibration and electro-magnetic noise.



VISION's new electron microscope and center members.

Second, the past year was also a milestone due to VISION's transition from focusing on competence establishment to scientific endeavors with many new, ground-breaking results. For example, VISION and SURFCAT colleagues succeeded in decoding the significance of the heterogeneous surface on Au nanoparticles for the electrocatalytic reduction of CO₂ to CO - a primary reaction of importance for the sustainable production of chemicals and fuels.

Specifically, atomic-resolved electron microscopy enabled our discovery that Au nanoparticles can be particularly selective towards the catalytic process, and that the selectivity relates to 8-fold coordinated surface “sites” pinned at grain boundaries of polycrystalline Au nanoparticles. These fundamental results also show that a high grain boundary density is a strategy to optimize nanoparticle-based catalysts for CO₂ electroreduction. The work was published in the high-profile *Journal of American Chemical Society*.

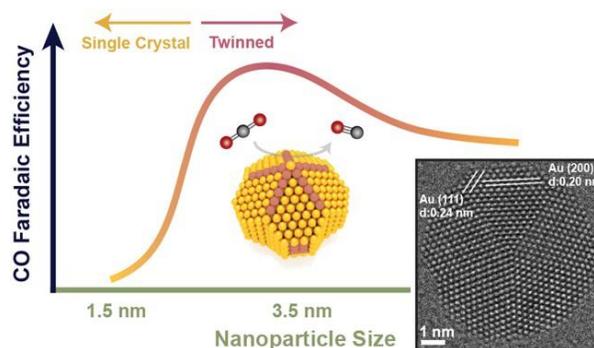


Illustration of CO₂ electroreduction to CO catalyzed by Au nanoparticles. The atomic-resolved electron microscopy image and ball-model show a polycrystalline (twinned) Au nanoparticle with crystalline grains (yellow balls) separated by grain boundaries (orange balls). Adapted from *J. Am. Chem. Soc.* DOI: 10.1021/jacs.3c10610