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Designing Catalysts for Meeting the DOE 150 °C Challenge for Exhaust Emissions

ABSTRACT: As more efficient combustion engines are developed for transportation, it is expected that less heat will be wasted in the exhaust, leading to lower exhaust temperatures. Hence DOE has set a goal of achieving 90% conversion of target pollutants by 150 °C [1]. To meet exhaust emission standards, it is necessary to develop catalysts that provide light off at lower temperatures than the current generation of catalysts (which become active at ~200 °C). The new targets cannot be achieved simply by increasing the loading of noble metals. One way to achieve higher reactivity at low temperatures is by control of the crystallite size of the platinum group metal (PGM) nanoparticles [2]. Smaller particles and sub-nanometer clusters show higher reactivity, and in the limit, we can envision single atom catalysts, which provide the highest atom efficiency to reduce noble metal usage, since every atom is involved in the catalytic cycle. The challenge is to make these single atom and sub-nm structures durable so they can survive high temperature aging protocols and demonstrate performance under realistic conditions.

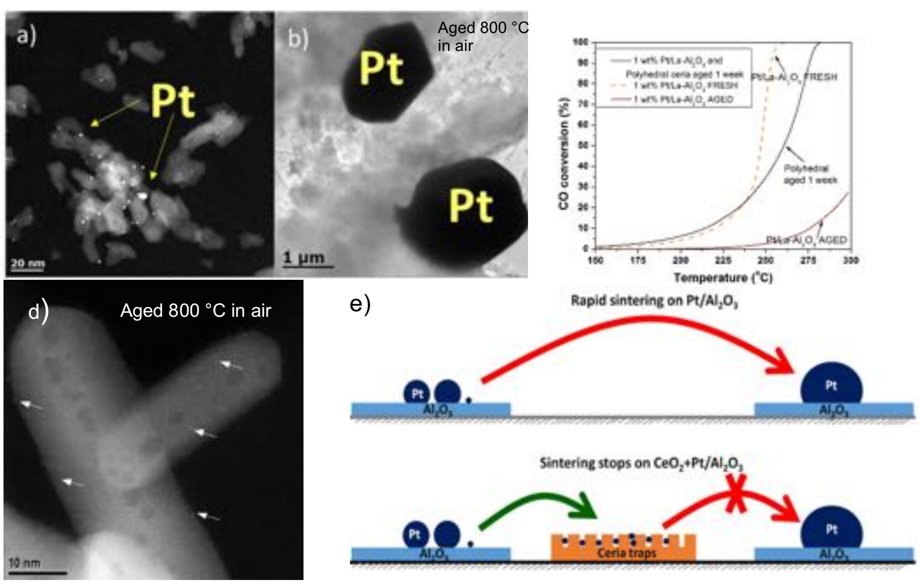

Figure 1 a) 1wt% Pt/La-Al2O3 fresh and (b) after aging in flowing air at 800 °C for 10h; (c) CO oxidation activity of the fresh and aged 1 wt% Pt/La-alumina and when polyhedral ceria was physically mixed before aging; (d) AC-STEM image showing atomically

This presentation will highlight our approach to enhance the reactivity and thermal durability of emissions control catalysts using single atom catalysts (SACs) [3,4].

References

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BIOGRAPHY: Abhaya Datye has been on the faculty at the University of New Mexico since 1984. Abhaya received his Ph.D. in chemical engineering from the University of Michigan. He has authored 230 publications, 6 patents and has presented 162 invited lectures around the world including the Europacat at Innsbruck, Austria, Faraday Discussion at Liverpool in the UK, WE Heraeus conference in Bad Honnef, Germany, the School for Electron Microscopy at Berlin and the Taniguchi conference in Japan. His published work has received ~13,000 citations with an *h-index* of 61 (Google Scholar). He is a fellow of the AIChE, the Microscopy Society of America and the Royal Society of Chemistry. He is involved in international collaborations, having led the successful NSF Partnership for International Research and Education (PIRE) on Conversion of Biomass derived reactants into Fuels, Chemicals and Materials (a collaboration between faculty and researchers in the US, Denmark, Germany, Netherlands and Finland). He has also done sabbaticals at BP in the UK, at Haldor Topsoe in Denmark and extended visits to the Univ. of Poitiers in France and he was honorary professor at the University of Witwatersrand in South Africa. He has been actively involved in the North American Catalysis Society, serving as co-chair for the Denver NAM 2017, program co-chair for the Snowbird NAM 1995. He was the Chair of the Gordon Research Conference on Catalysis in 2010.

His research group has pioneered the development of electron microscopy tools for the study of catalysts. Using model catalysts, his group has shown metal/support interfaces can be studied at near atomic resolution, making electron microscopy – a bulk technique – into a very sensitive and local probe of surface structure, which determines catalytic activity. His current work involves the synthesis of biorenewable chemicals, fundamental studies of catalyst sintering, and synthesis of novel nanostructured heterogeneous catalysts, especially the stabilization of isolated single atoms on supports. In 2016, the ACS publication Chemical & Engineering News included his research on single atom catalysis as one of the top 10 stories for the year. His research has been recognized through numerous awards, including John Matthews Lectureship, Microscopy Society of South Africa, 2013, NSF Industry University Cooperative Research Centers, 2008 Award for Excellence, Best paper Materials Science, Microscopy and Microanalysis, 2006, and Outstanding Research Award and Outstanding Teaching Award from the School of Engineering at the University of New Mexico.