The nano world of clean energy electrochemical systems – microscopy and spectroscopy of fuel cells, electrolyzers and batteries

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Governments around the world are showing a renewed, unprecedented interest in clean, renewable energy systems, such as fuel cells, electrolyzers, batteries, wind and solar. An especially increased focus is on hydrogen, a zero-carbon and renewable fuel, accelerating the transition to a global hydrogen economy. World-wide, governments, companies and other organizations are announcing new developments, consortia, infrastructure programs, and financial commitments to propel renewable hydrogen production and use [1-3]. The global hydrogen market value is expected to increase from 130 billion USD in 2020 to 201 billion USD by 2025 [4]. Hydrogen offers a unique chance to decarbonize trans¬portation, power generation, and manufacturing sectors and, thereby, address pollution and climate change challenges. Electrolyzers and fuel cells, devices that produce green hydrogen and use the same to generate power, respectively, are at the hearth of this global hydrogen economy boom. Batteries are already widely accepted solutions.

However, all these electrochemical devices still face challenges with performance, cost and durability, which often originate from the nano-scale of these devices. This talk will offer an overview of the research activities in the presenter's lab, in particular, the nano-world of fuel cells, electrolyzers and batteries. The talk will review advanced 2D and 3D characterization approaches in understanding the catalyst and electrode microstructures, and degradation mechanisms. Novel approaches to quantify a range of parameters from the microscopy and spectroscopy data will be presented and correlated to the performance.

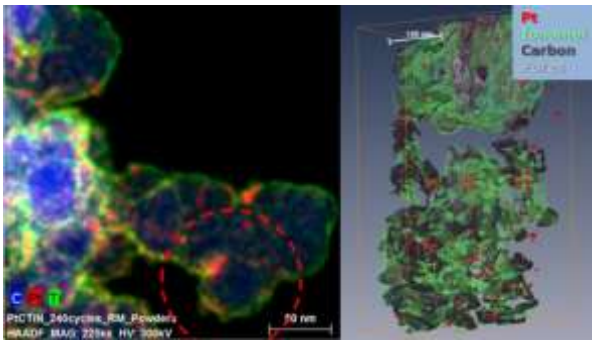

Figure 1. 2D and 3D microscopy images of fuel cell catalysts

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References

1. Hydrogen Council. Hydrogen Scaling Up - A sustainable pathway for the global energy transition, Hydrogen Council, 2017. https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-Scaling-up_Hydrogen-Council_2017.compressed.pdf
2. Adams J. DOE Hydrogen Heavy Duty Truck Targets. 2020.
3. Papageorgopoulos D. Fuel Cell R&D Overview. 2019 Annu Merit Rev Peer Eval Meet. 2019:33.
4. https://www.marketsandmarkets.com/Market-Reports/hydrogen-generation-market-494.html