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Plasma Interactions at the Interface with Liquids, Nanoparticles and Catalytic Surfaces

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Low temperature atmospheric pressure plasmas enable the delivery of highly reactive plasma species to a substrate at (near) ambient temperatures which is beneficial for a broad range of applications. In this presentation, we will focus on advances in our understanding of (1) the underpinning mechanisms of plasma-driven solution electrochemistry enabling green nanomaterial synthesis without the need of harmful chemicals [1,2]; (2) the interaction of plasmas with catalysts as a sustainable electrically driven route to synthesize or decompose chemicals [3,5] and (3) the H_2 plasma-enabled reduction of iron ore as a sustainable alternative to incumbent technologies [6].

While the applications are advancing rapidly in these areas, the mechanistic understanding of these interactions is lagging mainly due to a lack of in situ diagnostic capabilities. We show that detailed experimental characterization of well-designed canonical reactors allows us to develop simplified models of complex plasma-substrate interactions leading not only to a conceptual but also quantitative understanding of the key species involved in the interactions and the rate limiting processes for plasma-liquid interactions and plasma-catalysis. Furthermore, we highlight a newly developed diagnostic capability: operando environmental Transmission Electron Microscopy (TEM) in a plasma environment to probe the mechanism of iron ore nanoparticle reduction.

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