University of Central Florida
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Highly reactive, selective and reusable Ni foam-supported noble-metal-based catalysts for broad-scope hydrogenations

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The use of noble metal catalysts is widespread due to their exceptional activity and stability. However, their sustainability is challenging due to scarcity, both in terms of Earth-abundance and sources of production, and their associated high cost. To ensure the long-term availability and sustainable use of these catalysts, it is essential to design highly efficient systems that minimize the use of precious metals, maximize reactivity, and facilitate easy recovery and reuse. One promising approach involves using supported nanocatalysts (NCs). This approach allows for low catalyst loadings (compared to bulk material), prevents NC agglomeration during catalytic processes and enhances their separability from reaction products. Nonetheless, supported NCs can still face deactivation due to coking, sintering, leaching, etc.

Metal foams as catalyst supports, while underutilized compared to traditional catalyst supports (e.g., carbonaceous materials, metal oxides, zeolites, and MOFs), offer several advantages, including a macroporous 3-D structure that ensures complete coverage of catalyst, ease of handling and recyclability. Nickel foams, in particular, stand out for their stability, cost-effectiveness, and commercial availability. While Ni foams have seen extensive use in electrochemical and electrocatalytic applications, their potential in catalysis, including flow processes, remains relatively unexplored. We report a facile process developed in our group for highly reactive, robust, and reusable precious-metal-based NCs, including Pd and Pt secured onto contiguous Ni foams. Specifically, our Ni foam supported Pd catalysts, with a < 2 nm ALD Al2O3 overcoat have shown exceptional performance for hydrogenation reactions, including but not limited to nitrobenzenes, quinolines, styrenes, and phenylacetylenes (hydrogenation and semi-hydrogenation), under both batch and flow conditions. This presentation will focus on the catalyst design, scope of reactivity, and the source of selectivity in these reaction systems.