Catalyst Overcoating by Non-hydrolytic Sol–gel Technique

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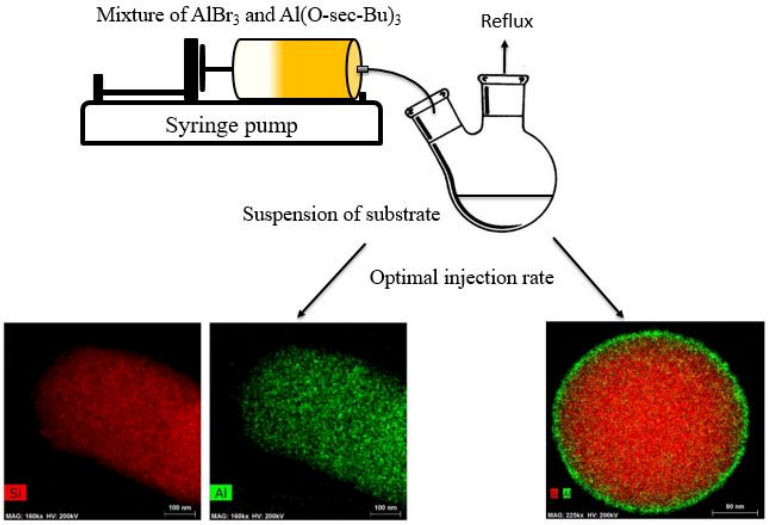
Catalyst overcoating has recently gained more attention in the area of catalyst synthesis. The overcoat can encapsulate active sites and serve as a physical barrier to isolate the nanoparticles, which prevents the sintering of particles during catalytic reactions. The overcoat can be tailored by varying synthesis parameters during methods including atomic layer deposition (ALD) or sol-gel techniques.

ALD has been widely applied to improve the stability of heterogeneous catalysts.[1,2] However, conducting ALD on powder samples is relative costly and difficult to scale up. On the other hand, sol-gel chemistry provides a more affordable and scalable alternative as well as allowing increased control over overcoat's porosity. Among various metal oxides, alumina (Al_2O_3) coating is particularly challenging since the kinetics of alumina precursors are too fast to be controlled using traditional sol-gel techniques. Herein, we demonstrate a novel strategy for coating Al_2O_3 based on non-hydrolytic sol-gel (NHSG) chemistry.[3] The precursor was prepared by mixing aluminum bromide and aluminum sec-butoxide. The gelation of this precursor cannot occur unless it is at high temperature. We controlled the kinetics of this alumina precursor by syringe pump injection, which allows us to uniformly overcoat alumina onto different supports with surface areas ranging from 15 m^2/g to 400 m^2/g. Further characterizations suggested that the coated samples had unusual strong Lewis acidity compared to commercial alumina supports. Current efforts are focused on applying this NHSG coating approach to design bi-functional heterogeneous catalyst for upgrading monomers derived from lignin—a major plant fraction that is one of the few natural sources of aromatic molecules.



Conformal overcoat formation on (left) SBA-15 and (right) silica sphere

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