Nanofiber Catalyst Supports and Solution-Based Processes for Deposition of Catalytic Metals and Metal Oxides

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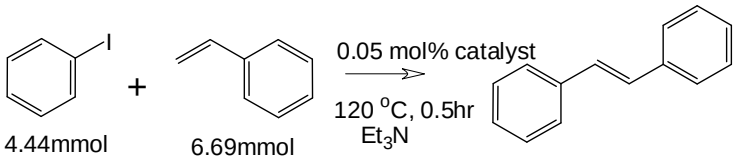
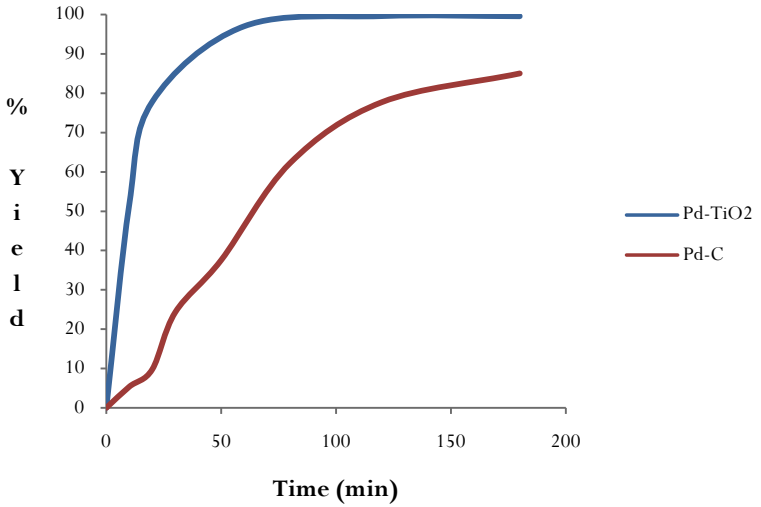
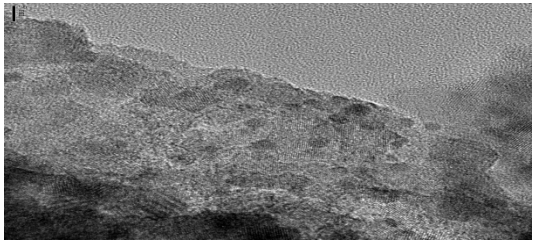
Heterogeneous catalysts have been of particular interest due to their low catalyst loading as well as ease of recovery and recyclability from reaction medium. Their stability at high temperatures, good selectivity and enhanced reactivity under mild conditions render these catalysts cost effective. Recent studies on metal nanoparticle catalysts suggest that the large surface area to volume ratios increase the interaction of catalysts with the reacting solutions. We have successfully fabricated titania nanofibers with dimensions ~150 nm subsequently followed by a 5 % loading of Pd nanoparticles (2 - 4 nm) on the TiO_2 nanofibers. A 0.05 mol % loading of Pd-TiO_2 catalyst exhibited a high activity and selectivity for the C-C coupling reaction in Heck catalysis, with selectivity values of up to 100 % and high yields of up to 99.6 %. These values were significantly higher than the commercially available Pd-C catalyst; unlike the Pd-C catalyst, Pd-TiO_2 was successfully separated from the reaction matrix at the end of the reaction and re-used for subsequent reactions.



Heck C-C coupling reaction of an olefin with iodobenzene

GC MS yield of Pd-TiO_2 vs Pd-C catalysts





Pd-TiO_2 catalyst

Other nanostructures fabricated include gold nanoparticles supported on TiO_2 nanofibers, metal/metal oxide nanotubes. Current work involve the application of these materials as catalysts and supports.

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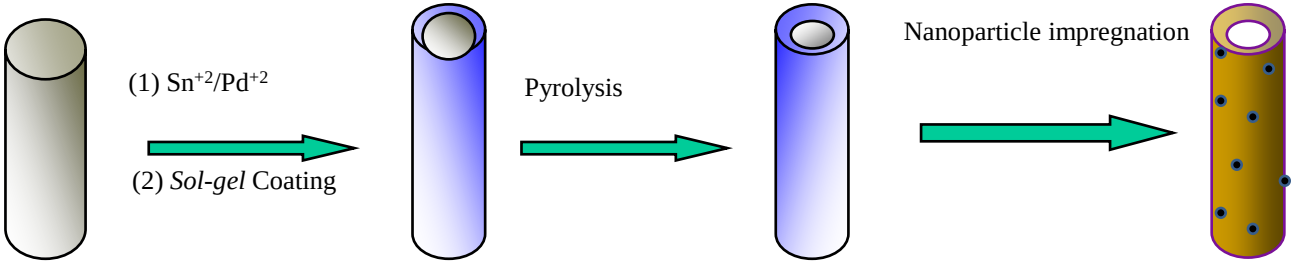
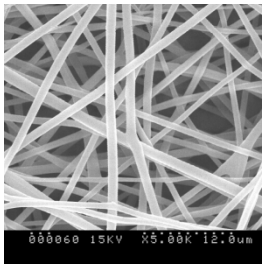
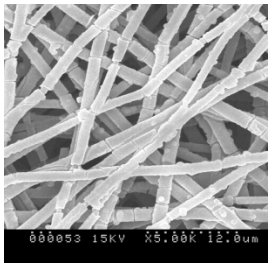
Scheme for the preparation of metal oxide nanotubes and impregnation with nanoparticle Catalysts.



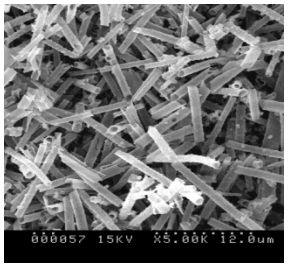
Polymer fiber, 200±50 nm



Coaxial fiber, 200±50 nm



Metal oxide nanotube, 200±50 nm



Catalyst supported on nanotube