J Material Sci Eng 2019, Volume 8
DOI: 10.4172/2169-0022-C2-129

New frontiers in 3D printing: structures for chemistry applications

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The burgeoning demand for 3D printing technology is due to the method's suitability as a means of controllable deposition of support and active material in order to produce structured catalyst arrays. Monolithic structures have found wide application in environmental management (such as carbon structured honeycomb monoliths for exhaust gas cleaning) and very limited application to date in the chemical industry due to the greater cost of capital investment involved in their manufacture in comparison to other shapes such as granules and beads. As opposed to the conventional randomly packed beds of catalyst bodies, structuring the catalysts into multi-channel reactors and bespoke 3D printed architectures will lead to greatly improved productivity/conversion due to the high surface area and precise and uniform product distribution. The model reactor systems that will be showcased are innovatively employed in industrially relevant chemical reactions. These monolithic multi-channel systems were developed using co-printed carbon-supported Pd catalyst or graphene-oxide supported mixed oxides and demonstrated to improve organic chemical synthesis routes. In order to extract the catalysts' pertinent morphological and chemical information and feed it back into the development of their structures, a combination of conventional characterization and advanced 3D-5D imaging techniques at multiple resolutions were used such as X-ray computed tomography (CT) and electron microscope techniques (STEM, EDX, HRTEM). The initial results on 3D catalysts in representative reactions are promising suggesting that 3D printing is an adaptable, versatile tool for tailoring the support macro- and microstructure and precursor distribution by controlling initial materials and their co-printing parameters.

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