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New frontiers in greener catalysis: 3D printed chemical reactors

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The ordered packing of chemical reactors has found wide application in environmental management (such as carbon structured 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 burgeoning demand for 3D printing technology is due to the method's suitability as a means of controllable deposition of support and an active material in order to produce structured catalyst arrays. The model reactor systems that will be showcased are innovatively employed in industrially relevant chemical reactions. A monolithic multi-channel system was developed using co-printed carbon-supported Pd catalyst to improve organic chemical synthesis. Another system under study is graphene-oxide (GO) based 3D structured catalyst that was produced using a green, rapid, chemical synthesis route combining the unique properties of graphene and active nanocomposite particles for CO_2 utilization reaction. The initial results of this study on representative reactions are promising as no separation of the catalyst from the product is needed (with no leaching of the catalyst from the support). In addition to catalytic testing in order to extract the catalysts' pertinent morphological and chemical information and feed it back into the development of the catalyst structures, a combination of conventional characterization and advanced 3D imaging techniques at multiple resolutions were used.

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