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A Novel method for the preparation of a monolithic alumina catalyst support

First used to facilitate oxidation reactions in 1800s, heterogeneous catalysts now play important roles in many other catalytic processes, such as hydrocarbon reforming, polymerization, hydrogenation, dehydrogenation, long-chain hydrocarbons cracking and isomerization reactions. Nowadays, heterogeneous catalysis is the core of most modern conversion processes in the natural gas reforming, petrochemicals manufacture and oil refining sectors. Recently, there has been considerable interest in the development of more efficient catalysts able to operate efficiently under severe reaction conditions. Catalyst stability is a key challenge in this area. One of the main components of many heterogeneous catalyst systems is an inorganic support. Such supports often play a key role in the performance of the catalysts. Alumina is one of the most frequently used catalyst supports, due to its thermal stability and high specific surface area. Enhancing the catalytic performance of catalysts by modification of the micro and macro structure of the alumina support has been the focus of numerous studies. Alumina monoliths represent an attractive alternative to conventional supports in some applications, in particular, those which involve high flow rates.

Monolithic ceramic supports are typically produced by injection moulding techniques; however such processes are not suited to materials with low plasticity, such as alumina.

In this study, a novel process was developed to enable the manufacture of a monolithic alumina support by combining 3D printing with an aqueous gelcasting method. A sacrificial resin mold, produced by 3D printing and gelcasting was employed to form a green body through polymerization of an aqueous slurry. The slurry was prepared using acrylamide as an organic monomer, N, N'-methylenebisacrylamide as a cross-linking agent, ammonium persulfate as initiator, sodium silicate as dispersant and N,N,N',N'-tetramethyl ethylenediamine (C₆H₁₆N₂, TEMED) as the catalyst. The optimum amounts of monomer, initiator, catalyst, cross-linking agent and dispersant was identified and the effect of various operating variables, such as the milling time and the drying method, were studied.

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