Applied Catalysis A: General 427–428 (2012) 66–72

Contents lists available at SciVerse ScienceDirect

Applied Catalysis A: General

journal homepage: www.elsevier.com/locate/apcata

Carbon-coated structured supports. Preparation and use for nitrobenzene hydrogenation

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ARTICLE INFO

Article history:
Received 18 November 2011
Received in revised form 27 February 2012
Accepted 22 March 2012
Available online 30 March 2012

Keywords:
Carbon washcoating
Resin
Structured catalytic reactors
Stainless steel
Foam
Slurry
Nitrobenzene hydrogenation

ABSTRACT

Whereas carbon is a major catalyst support, namely in pharmaceutical industry, its immobilisation on structured objects has scarcely been studied. This article presents the comparison of two methods aiming at coating ceramic and metallic supports with a carbon layer. The method involving a suspension of black carbon is easy to use but leads to less adherent layers than the method involving the carbonisation of poly(furfuryl alcohol). On the other hand, the former method is the one that allows to prepare more active catalysts for nitrobenzene hydrogenation. Then, the suspension formulation has been improved to enhance the carbon adhesion.

1. Introduction

Among the variety of catalyst supports, carbon is one of the preferred ones, but its immobilisation on structured surfaces is much less studied than that of many other supports, e.g. alumina because of smaller interactions between the support and the coating [1]. Whereas several ways to obtain oxide-coated objects have been described [1–3], few can be adapted to obtain carbon-coated objects. The suspension method (dip-coating in a slurry of particles) and the electrophoretic deposition would possibly adapt well. However, the deposition of carbon with these methods based on a slurry of carbon particles has been scarcely used for catalysis purposes. Some examples are reported concerning sensors [4] or composite materials [5].

Concerning catalysis applications, most of the publications deal with the use of a resin as the carbon precursor. Since the pioneering work of Hucke [6] concerning the preparation of carbonaceous structures, carbon coating from a polymeric resin has been extensively studied and described for ceramic monoliths [7,8] and ceramic foams [9,10]. However, by this method, very few articles deal with carbon deposition on non-ceramic structures. Schimpf et al. [11] describe the coating of AlMg microchannels (0.3 mm × 0.7 mm × 50 mm), Acharya et al. [12] describe the coating of stainless steel discs by spray-coating to obtain membranes, Hajiesmaili et al. [13] describe the preparation of carbon foams by shape memory synthesis. A hybrid procedure has been used by Garcia-Bordeje et al. [14] to obtain activated carbon on monoliths. The monoliths were dipped in a mixture of polymer and carbon powder. The main other method reported in the literature is the direct growing of carbon nanofibres on substrates. Again, this method has mainly been used to coat ceramic monoliths [15–17]. One recent publication concerns the way to grow carbon nanofibres on stainless steel microreactors. The method is elegant but requires many successive steps [18].

In our work, we have tried to extend the use of resin coating to other families of structured surfaces, such as stainless steel foams, grids and plates. We have also tried to use a simple suspension method based on a slurry of commercial carbon. Both methods have been compared in terms of carbon loading and adherence on different materials. The carbon-coated ceramic objects have been impregnated with a palladium precursor and used in nitrobenzene hydrogenation to check their catalytic performances. The same reaction was used by Machado et al. [19] to demonstrate the possible replacement of slurry catalysts by monolith catalysts in the G/L/S synthesis of fine chemicals.

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http://dx.doi.org/10.1016/j.apcata.2012.03.031