CeO_2-BASED CATALYSTS WITH ENGINEERED MORPHOLOGIES FOR SOOT OXIDATION TO ENHANCE THE SOOT-CATALYST CONTACT

P. Miceli, S. Bensaid, D. Fino
debora.fino@polito.it
Department of Applied Science and Technology, Institute of Chemical Engineering
Politecnico di Torino, Corso Duca degli Abruzzi 24, I-10129, Turin, Italy

PM emission reduction is a challenging technological step for diesel engines, and is being tackled in the framework of a strict regulation worldwide. Diesel particulate filters (DPF) are the most common devices for the collection of particulate matter from diesel exhausts. Most DPFs perform a catalytically assisted regeneration. Since soot particles and the catalyst grain sizes often have different orders of magnitude, this leads to a poor accessibility of the soot particles to the catalyst inner porosities. This aspect could be rate-limiting especially at low temperatures. In this work, in order to improve the soot-catalyst interaction, the morphology of the catalyst was designed in the attempt to maximize the number of contact points: CeO_2 in the form of nanofibers and self-assembled stars were synthesized to this end .

As far as the activity results are concerned, if one focuses on the onset temperatures, it is clear that a remarkable advantage is obtained with the CeO_2 catalysts as compared to the non-catalytic case. In particular, the self-assembled stars exhibit the best performances. This is explained by their superior specific surface compared to one of the powders and of nanofibers. In fact, in tight conditions, an intimate soot-catalyst contact is reached, leading to soot oxidation kinetics which are strictly dependent on the abundance of adsorbed oxygen, and are not rate-limited by a poor soot-catalyst contact.

Loose contact conditions were also evaluated: in this case, the morphology of the catalyst plays a relevant role in determining the nature of the soot-catalyst contact. The fibrous morphology was sought in the attempt to maximize the number of contact points between soot and the catalyst, by allowing a better penetration of soot in the network of nanofibers, which is characterized by a very high open porosity. This concept was observed in loose-contact soot oxidation, in which nanofibers promoted soot combustion at low temperatures, despite a very poor specific surface, especially as far as the onset temperature was concerned.

These results suggest to engineer the morphology of the catalyst to enhance the soot-catalyst contact, as allowed by the nanofibrous structure, and to spur the specific surface to avoid kinetic limitations due to oxygen low coverage, as achieved with the self-assembled stars.

10.4405/profic2014.B10