Pd-FECRALLOY FOAM CATALYSTS FOR THE OXIDATION OF CO AND CH_4

S. Cimino[1], G. Mancino[1], L. Vazquez-Gomez[2], E. Verlato[2]
stefano.cimino@cnr.it
[1] Istituto di Ricerche sulla Combustione (IRC-CNR), P.le Tecchio 80, Napoli, Italy
[2] Istituto per l'Energetica e le Interfasi CNR, Corso Stati Uniti 4, 35127 Padova, Italy

Palladium represents a major constituent of the automotive Three Way Catalysts for the abatement of hydrocarbons, CO and NO_x emissions, in substitution of, or in addition to, Pt and Rh which are significantly more expensive. Moreover it is the most active precious metal for methane combustion in excess of oxygen (lean conditions). For that reason, structured Pd catalysts are strongly recommended for depollution of emerging natural gas-powered vehicles and in catalytic processes for energy production from natural gas. In the present work, we report on a new simple approach to the preparation of structured technological catalysts for environmental applications, based on the spontaneous deposition of Pd onto Fecralloy foam substrates, obtained through the direct immersion of the foam in a solution of Pd^{2+} chloro-complexes, and on their use in CO and CH_4 oxidation. Since the noble metal deposits formed by spontaneous deposition are in electrical contact with the metallic foam, electrochemical methods can be used to determine their surface area, through the measurement of the electrical charge associated with the reduction of electrochemically generated Pd surface oxides. Furthermore, the direct Pd-Fecralloy contact may cause a strong interaction between the noble metal and the iron-based metal support, which has been reported as a key factor to boost CO oxidation, at low temperature, through the activation and reverse spillover of oxygen from the support itself. Catalysts characterization also included electrochemical techniques (cyclic voltammetry, EIS), SEM-EDX, ICP-MS, XRD, TPR/TPO, performed both on freshly prepared and reaction aged samples. CO and CH_4 catalytic oxidation under lean (oxidizing) conditions were selected as test reactions occurring respectively in the low (100-300 °C) and mid-high (300-600 °C) temperature ranges.

Pd-Fecralloy foam catalysts were found to guarantee good activity with an effective utilization of the noble metal content in spite of their relatively low Pd dispersion. The low temperature intrinsic activity of the Pd-Fecralloy catalysts towards the oxidation of CO under lean conditions was found to benefit from a direct interaction between the noble metal and the metallic carrier, probably related to a reverse oxygen spillover. Such an effect tends to disappear for progressively higher Pd loadings on the surface of the foam.

Regarding the oxidation of methane under lean conditions, the intrinsic activity was found to be largely independent of the noble metal loading, and the interaction with the Fecralloy support did not alter the specific catalytic features of Pd. From the technical point of view, when comparing the CH_4 reaction rate per unit volume of the structured catalytic reactor, it was found that Pd directly deposited on Fecralloy could be as much as 10 times more effective than a more traditional catalyst with a Pd/alumina active washcoat.

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