Aerosol Synthesized Porous Catalytic Particles for Emission Control Applications

G. Kastrinaki[1,4], M. Kostoglou[3] and A.G. Konstandopoulos[1,2]

[1]Aerosol &Particle Technology Laboratory, CERTH/CPERI, Thessaloniki, P.O. Box 60361, 57001, Greece
[2] Department of Chemical Engineering, Aristotle University, Thessaloniki, PO. Box 1517, 54006, Greece
[3] Department of Chemistry, Aristotle University, Thessaloniki, PO. Box 1517, 54006, Greece
[4] Department of Mechanical Engineering, University of W. Macedonia, Kozani, 50100, Greece

Keywords: porous particles, aerosol spray pyrolysis
Presenting author email: georgiak@cperi.certh.gr

In automotive emission control applications one is targeting the oxidation of hydrocarbons (HC) and carbon monoxide (CO) towards non toxic gases carbon dioxide (CO_2) and water (H_2O), In addition oxidation of nitrogen monoxide NO to nitrogen dioxide (NO_2) is often desired, before any final nitrogen oxides (NO_x) reduction, since NO_2 plays important role in Diesel Particulate Filter (DPF) regeneration and Selective Catalytic Reduction (SCR) reactions. Gas oxidation (NO, HC, CO) is facilitated by catalytic materials, mainly Platinum (Pt) Group Metals, that are dispersed on a high surface area oxide material (support) such as silica, alumina etc, .

The goal of this work is to employ Aerosol Spray Pyrolysis (ASP) (Karadimitra et al, 2001). for the one-step synthesis of catalytic systems (Pt on oxide particles). The small size of aerosol particles would increase the catalyst surface area while the one-step synthesis would enhance the productivity of the process. In ASP, a solution of metal precursors is atomized into fine droplets, which undergo evaporation of the solvent and precipitation of the dissolved material, which upon further thermal treatment is converted to the oxide form of the metal precursors. The control of the different synthesis parameters such as the precursor material and its concentration, the solvent type, temperature, flow rate and post treatment determine the particle characteristics and generation of porous nanoparticles has been already reported (Lorentzou et al, 2011).

In the present work Pt loaded porous silica and alumina nanoparticles (with a 200 nm mean particle size) at different Pt loadings have been synthesized and characterized for their catalytic oxidation activity.

The catalytic particles were tested in a fixed bed reactor system with respect to their catalytic activity for NO oxidation to NO_2 as well as for C_2H_4 oxidation in a feed stream of 10%O_2 in N_2. The evaluation was performed in the presence and absence of HCs in order to also assess inhibition effects. A theoretical model was also developed and was shown to describe satisfactorily the experimental data at moderate levels of conversion, while when mass transfer limitations were included in the model, the agreement with the experimental data over the entire conversion range was excellent.

Figure 1 provides a representative result for the oxidation of C_2H_4 on some of the catalytic nanoparticles produced (consisting of Pt/porous alumina). For oxidation comparison, Pt impregnated in commercially sourced alumina procured under similar experimental conditions is also shown. The aerosol-based catalyst has a significantly higher activity which is attributed to a combination of higher surface area and dispersion, currently under investigation.

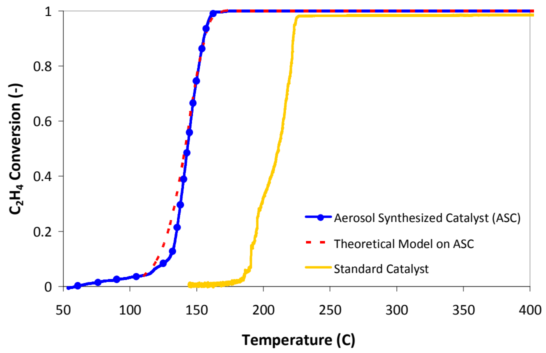

Figure 1. C_2H_4 oxidation on aerosol-based and commercially procured materials at the same Pt load.

The current work demonstrates the potential of aerosol-synthesized porous nanoparticle catalysts for automotive emission control applications. Work is continuing with the scaling-up of the production process of the porous catalytic nanoparticles and their incorporation into monolithic reactors for testing under realistic exhaust conditions on engines.

Lorentzou S., Kastrinaki G., Pagkoura C., Konstandopoulos A.G. (2011), *Nanoscience and Nanotechnology Letters,* 3, **5**, 697-704.

Karadimitra K., Papaioannou E., Konstandopoulos A.G (2001), *J. Aerosol Sci*., **32**, Suppl. 1, S233-234.