New PGM-free nanocomposites for TWC application

The pollutants removal from the exhaust of internal combustion engines is a major environmental catalysis challenge. In the three-way catalysts (TWC), the simultaneous oxidation of CO and unburned hydrocarbons (HCs), and reduction of NO has to be achieved efficiently, due to the progressive tightening of environmental regulations. K-INN Lab, the Prof. P. Canu's research group at DII in cooperation with Prof. A Glisenti's group at DiSC, have been supported by collaborative European projects (in 7th Framework and Horizon-2020 Programmes) to develop and test novel eco-friendly nano-structured automotive catalysts utilizing metal nanoparticles (Cu, Ni, Co, Zn, etc) that can partially or totally substitute the Platinum-Group-Metals (PGM), expensive and critical raw materials.
The activity focuses on the design and realization of an experimental lab-scale rig (Figure 1) for the evaluation of the activity of novel catalysts, in form of powders or monoliths, with simulated exhaust mixture, under steady and transient operations, including accelerated aging. The catalyst samples are tested in a tubular flow reactor and the effects of GHSV (contact time), temperature, inlet composition thoroughly studied. The setup is also used for other gas-solid reactions, including soot generation and oxidation.
The recent work addressed transient and stationary experiments on perovskites, synthetized by Impact lab at DiSC and other European partners, with hydro-thermal aging treatments for the investigation of deactivation mechanisms (due to water vapor, sintering, cooking). The synthetic gas mixture fed approaches the actual exhaust composition, simulating stoichiometric, rich and lean conditions. Some of the samples studied are cobaltites and nickelates (LaCoO3 and LaNiO3) functionalized by a surface dispersion of different amounts of CuO nanoparticles. The % removal of each pollutant as a function of temperature (Figure 2) proves the effectiveness of the catalysts.

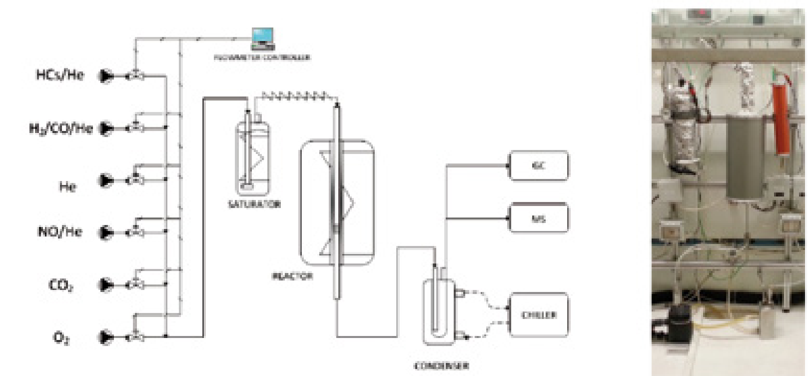

Figure 1. Experimental setup for the evaluation of catalytic activity.

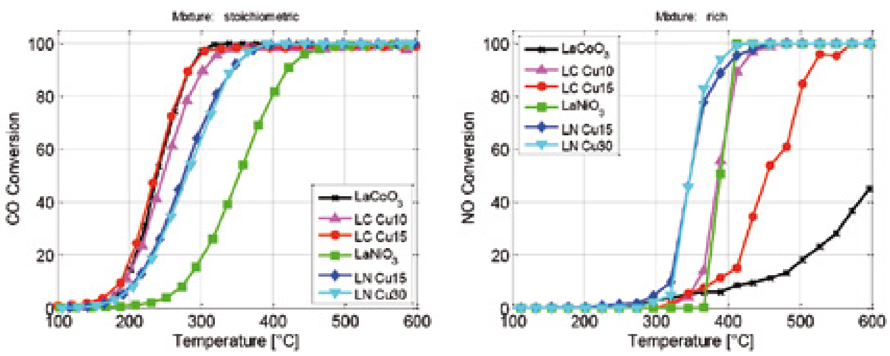

Figure 2. Conversion of CO over the temperature obtained in stoichiometric conditions (λ=1), on the left, and conversion of NO over the temperature obtained in rich conditions (λ=0.6), on the right.

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Main research topics:
- Development of catalytic technologies for the abatement of environmental pollutants
- Experimental investigation on the mechanisms involved in complex reactant systems, for relevant industrial reactions