Doped ceria catalysts for an innovative self-cleaning domestic oven

Pietro Palmisano[1], Nunzio Russo*[,1], Debora Fino[1], Guido Saracco[1], Vito Specchia[1],
Paolo Faraldi[2], Davide Polverini[2], Leonardo Arteconi[2]
[1] *Department of Materials Science and Chemical Engineering, Politecnico di Torino*
Corso Duca degli Abruzzi 24, 10129 Torino (Italy)
[2]*Indesit Company, Innovation and Technology*
Via Lamberto Corsi 55, 60044 Fabriano (Italy)
*nunzio.russo@polito.it

Introduction

The present work is aimed at developing oven walls with self-cleaning properties, via catalytically enhanced thermal oxidation of soil at temperatures within the available range of standard ovens, i.e. up to 300°C, substituting pyrolytic commercial oven already present in the marked working at 500°C [1,2]. As catalyst reference, it was chosen the CeO_2 well known for its oxidative properties towards solid pollutant species [3], and it was doped to improve its catalytic activity. The catalytic activity towards real soils was also tested in a temperature programmed combustion (TPC) apparatus.

Materials and Methods

A series of doped cerium oxides ($Ce_{0,9}X_{0,1}O_{1,9}$ where X was an earth-alkaline element) were chosen as oxidative catalysts and synthesized by the "Solution Combustion Synthesis" (SCS) method [3]. All the catalysts were analyzed by XRD, BET and SEM analysis to ascertain their cristallinity degree, the specific surface area and the morphology. Milk concentrate in powder, tomato paste, sauté cube and apricot jam were selected as representative soils. The catalytic activity of the synthesized samples towards the combustion of the selected soils was tested in a Temperature Programmed Combustion apparatus (TPC) described in [4]. The soils combustion was monitored via a NDIR analyser by measuring the CO_2 and CO concentrations in the reactor outlet gases. The temperature corresponding to the CO_2 peak (T_P) was taken as an index of the activity of each tested catalyst: the lower the T_p value, the more active the catalyst. Finally, the fresh catalysts were submitted to a specific ageing thermal treatment (750°C for 2 h) and the physical and chemical characterization analyses described above were replicated on aged samples.

Results and Discussion

The diffraction spectra recorded for all the prepared catalysts (not reported) confirm the presence of a crystalline cerium oxide phase (JPCDS card: PDF 65-2975) in any of the catalysts synthesised. Reflections regarding segregated phases were not detected. The specific BET surface areas of the prepared catalysts have values in the range 15-40 m^2/g. SEM observations (not reported) of the microstructure of the crystal aggregates of the catalysts enlighten a very foamy structure, a typical future of catalysts synthesized by SCS. Shifting the attention to the catalytic activity, in all cases the TPC tests showed that the presence of catalysts always improved the combustion of soils if compared with the non-catalytic oxidation that was reported as reference. The figure 1 reports the results regarding the apricot jam combustion in presence and in absence of catalysts. In this case, apricot jam non-catalytic oxidation occurred close to 500°C, while the presence of CeO_2 allowed a T_p of 250°C, and the complete conversion well below 300°C. The fresh doped CeO_2 catalysts did not show an appreciable improvement of the catalytic performances respect the not doped ceria (see Table 1). As far as the activity of catalysts after the ageing treatment is concerned, no serious deactivation was found. The CeO_2 and the doped $Ce_{0,9}Mg_{0,1}O_{1,9}$ catalytic materials were those which showed the best thermal proof properties.

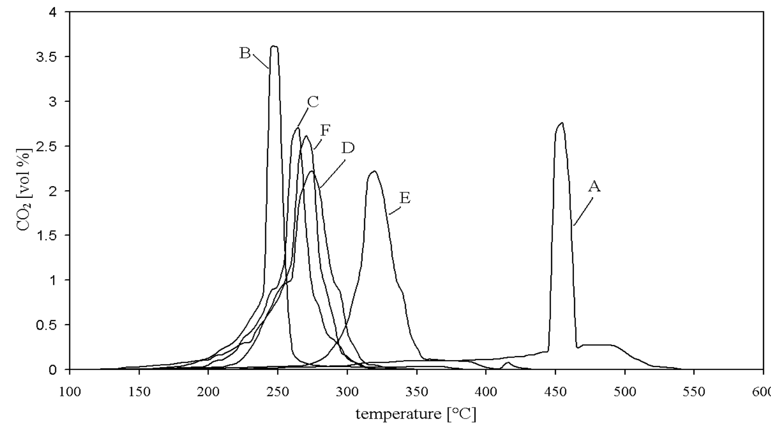

Figure 1. TPC plots for apricot jam combustion. A) no-catalyst; B) CeO_2; C) $Ce_{0,9}Mg_{0,1}O_{1,9}$; D) $Ce_{0,9}Ba_{0,1}O_{1,9}$; E) $Ce_{0,9}Sr_{0,1}O_{1,9}$; F) $Ce_{0,9}Ca_{0,1}O_{1,9}$.

Table 1. Results of the TPC runs performed with: A) no-catalyst; B) CeO_2; C) $Ce_{0,9}Mg_{0,1}O_{1,9}$; D) $Ce_{0,9}Ba_{0,1}O_{1,9}$; E) $Ce_{0,9}Sr_{0,1}O_{1,9}$; F) $Ce_{0,9}Ca_{0,1}O_{1,9}$

T_p [°C]	A	B	C	D	E	F
Apricot jam	455	245	265	275	320	270
Milk powder	500	225-485	315-475	255-415	220-365	330-480
Sauté cube	345-420	255	310-435	310	310	255-310
Tomato concentrate	540	475	425	490	490	480

References

1. GfK Marketing Services Italia – *Global Appliances Market Survey* (2006).
2. Appliance Magazine – *54th annual report* (2007).
3. Palmisano, P., Russo, N., Fino, P., Fino, P. and Badini, C. *Appl. Catal. B: Env.* 69, 85 (2006).
4. Russo, N., Furfori, S., Fino, D., Saracco, G. and Specchia, V. *Appl. Catal. B: Env.* 83, 85 (2008).