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Morphological evaluation of catalytic filters produced by wet and dry Ni-deposition on natural silica fibers

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Abstract – Catalytic filters were obtained from natural amorphous silica fibers (NASF) and ($Ni(NO_3)_2$ solution (wet route) and NiO (dry route) as catalyst precursors. Morphological characterization revealed that Ni from wet route was distributed over the silica fibers with significantly lower particle size than Ni produced by dry route. Both methods led to a homogeneous distribution of Ni, with relatively high dispersivity. The processes to obtain nickel catalytic filters are simple and efficient by both routes to reduce nickel oxide to metallic nickel (500°C).

Due to problems generated by the atmospheric pollution new environmental technologies require highly efficient separation and cleaning techniques for pollutes released from combustion processes, like CO, HC, NO-NO_2 and particulates [1,2]. In this work Ni-based catalytic filters were prepared by wet and dry routes. In the dry route, the NAS fibers, bentonite and NiO (10 wt.%) were dry mixed and humidified. In the wet route aqueous suspensions containing NAS fibers and 5 wt.% bentonite were prepared. The suspensions were homogenized, dried and disaggregated. The powder was added in the nickel nitrate solution (0,5M), stirred and heated for 3h. The dry powder from both routes was humidified and uniaxially pressed at 5.4 MPa. The green compacts were then heated up to 500°C in a 5%H_2/95%N_2 atmosphere for reduction of NiO, followed by a temperature increasing up to 1000ºC/60 min at 10°C/min in a N_2 atmosphere. The real density (ρr) of the sintered samples was measured by using a He-picnometer and the apparent density (ρ_{ap}) was geometrically measured. Porosity was calculated according to the expression $[1-(\rho_{ap}/\rho_r)]$). The specific surface area was measured by BET N_2 adsorption. Both routes presented similar BET surface areas (12 g/m^2 for wet route and 11 g/m^2 for dry route) and similar porosity (62% in average). Scanning Electron Microscopy (SEM) evaluation revealed that particles of Ni were homogeneously distributed over the NAS fibers (Figure 1). Color mapping of Ni for both samples revealed that Ni obtained from dry route exhibits a higher degree of dispersion, while Ni obtained by wet route is agglomerated. Particle size distribution (obtained by image analysis – IMAGO®) of Ni over the NAS fibers for wet and dry routes is shown in Figure 2. By dry route particles are distributed in a broad range of sizes, with mean size of approximately 0.2 µm, while by wet route, the majority of particles are significantly smaller. Fibrous ceramic filters with Ni distributed over the fiber surfaces could be used to remove particulates and purify the gases generated in the diesel combustion.

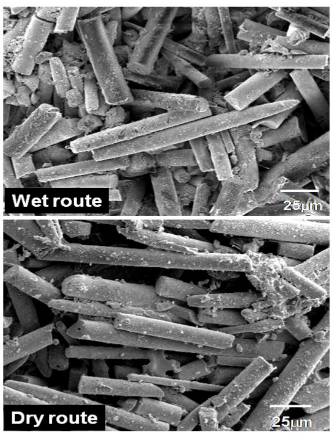

Figure 1: SEM micrographs of NAS fibers, with Ni deposited by wet and dry routes.

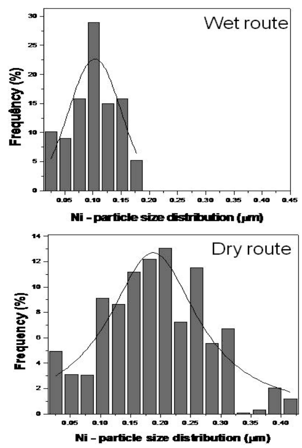

Figure 2: Particle size distributions of Ni deposited on NAS fibers

[1] S. Heidenreich, M. Nacken , M. Hackel, and G. Schaub. Powder Technology . 180 (2008) 86-90.
[2] U. G. Alkemade & B. Schumann. Solid State Ionics. 177(2006) 2291–2296..