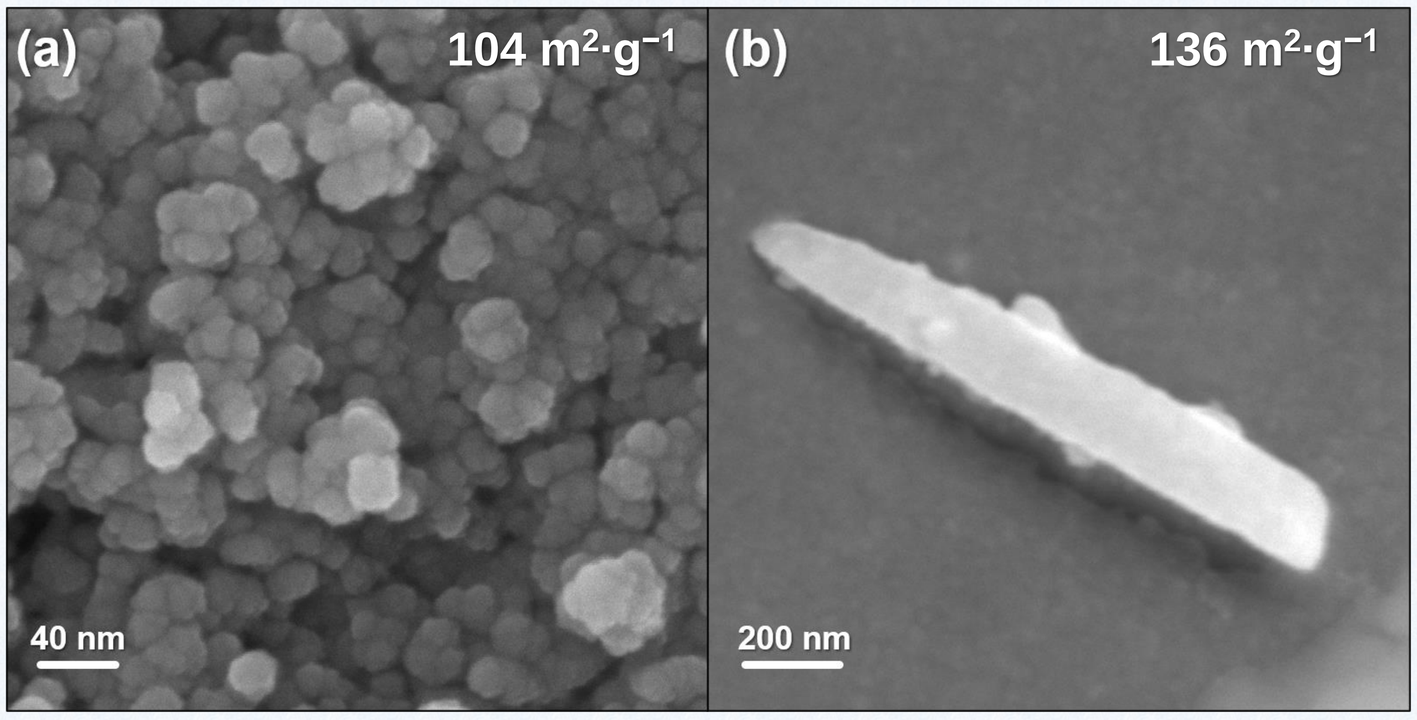
Ceria-supported metal nanoparticles for CO abatement in combustion exhaust gases

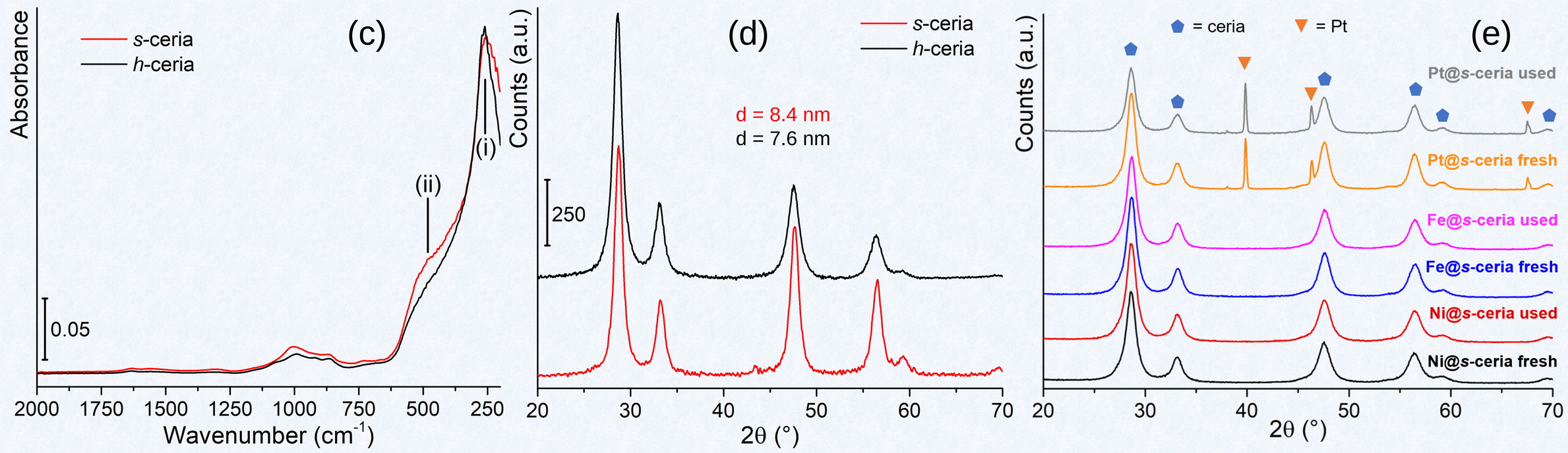
A. Lazzarini[1]*, L. Atzori[2], L. Arrizza[3], F. Ferella[4], G. Cutrufello[2], M. Crucianelli[1]

[1] DSFC, University of L'Aquila, via Vetoio (COPPITO 2), 67100, L'Aquila, IT
[2] DSCG, University of Cagliari, Cittadella Universitaria (Blocco D) - S.S. 554 bivio per Sestu - 09042 Monserrato (CA), IT
[3] Centre for Microscopy, University of L'Aquila, via Vetoio (COPPITO 1), 67100, L'Aquila, IT
[4] DIIIE, University of L'Aquila, piazzale Ernesto Pontieri, Monteluco di Roio, 67100, L'Aquila, IT

Abstract: In order to reduce CO emissions in power and industrial plants, a series of ceria-supported catalysts have been synthesized and characterized. Encouraging preliminary catalytic tests show, at least for one sample, a reactivity comparable to the *state-of-the-art* Pt-based catalyst.



Two synthetic routes for supports were attempted: *soft template* using CTAB as templating agent (*s*-ceria; Fig. a)[1] and *hard template* using SBA-15 as templating agent (*h*-ceria; Fig. b).[2]
Dimension of the particles, aspect ratio and surface area values varied depending on the procedure employed. Catalysts were produced by incipient wetness impregnation with nominal 5%$_{mol}$ of Ni, Fe and Pt.[1]



ATR-IR (Fig. c) identifies two peaks related to Ce-O ν_{symm} at 250 cm^{-1} (i)[3] and ν_{anti} at 500 cm^{-1} (ii).[4] Ceria template do not affect greatly crystal structure and dimensions (Fig. d), even though aspect ratio changes considerably; Ni and Fe metal active phase is not detectable by XRD prior and after testing (small particles), while Pt aggregates already in the synthetic step (Fig. e).

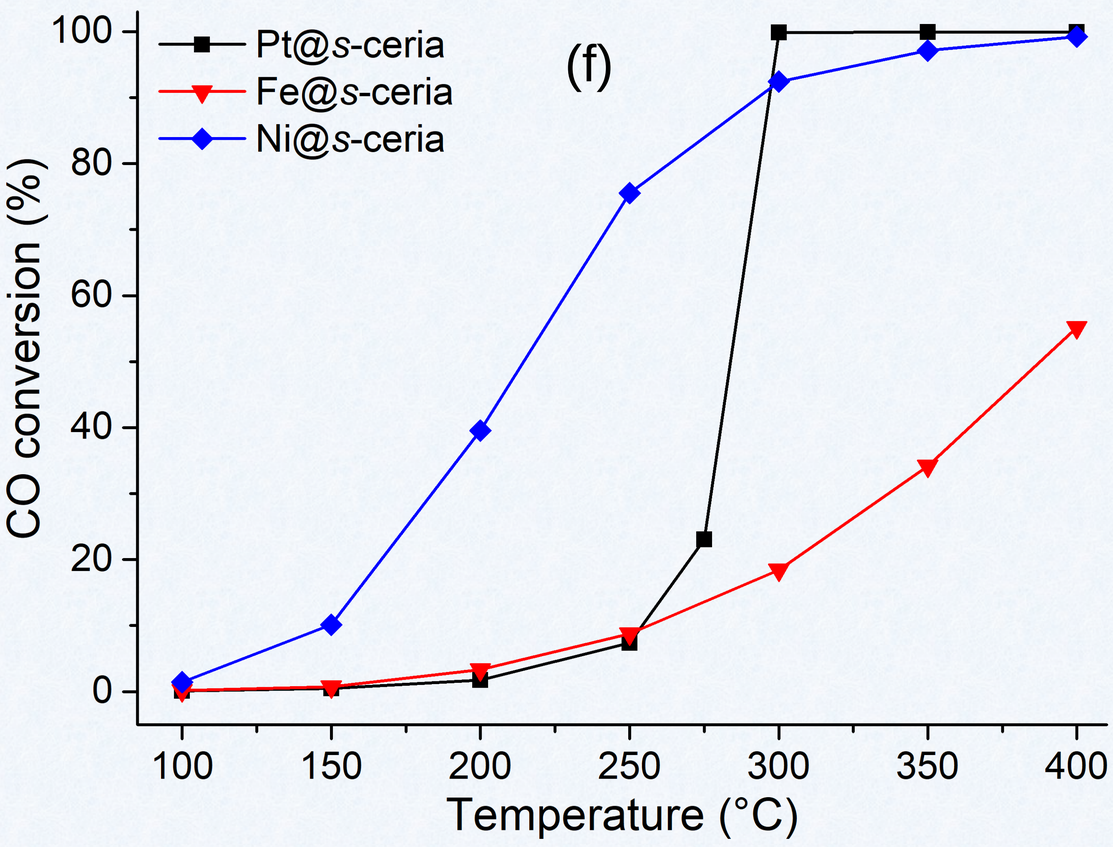


Fig. f) CO oxidation (CO = 2% v/v; O_2 = 8% v/v; N_2 balance; 50 mg catalyst; $0.12 \cdot 10^6$ cm^3 h^{-1} g_{cat}^{-1})[5] performed with Fe@*s*-ceria stops at 55% conversion (far from law requirements).
Ni@*s*-ceria reaches 100% conversion at 400 °C *vs* the 300 °C of Pt; however, the exhaust gases temperature is close to 400 °C, making Ni a valid alternative to Pt for CO oxidation.

Conclusions

We optimized the syntheses of different ceria morphologies, characterized with a wide set of techniques. We deposited Fe and Ni active phases, with excellent dispersion level (undetected from XRD). Conversely Pt aggregated considerably; however, it retained its excellent conversion, reached by Ni-based catalyst, that will be further explored in the future.

References: [1] Int. J. Hydrog. Ener., 2016, 41, 6316; [2] Microporous Mesoporous Mater., 2016, 226, 466; [3] J. Sol-Gel Sci. Technol., 2009, 52, 356; [4] Sci. Tot. Environ., 2011, 409, 2987; [5] ACS Catal., 2020, 10, 11356.