Graphene-coated oxides studied as support for mono- and bimetallic cobalt catalysts

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Abstract

Previous studies have shown that the catalytic performance of supported metal particles is notably influenced by their substrate. Metal oxides are common supports in many industrially relevant reactions due to their robust mechanical properties and low cost. The present work evaluates the influence of a graphene layer over SiO_2 and ZnO, on the redox properties of Co and PtCo overlayers. A large-area, low-defect density, graphene protective layer on planar oxide supports was prepared by wet transfer of single layer CVD-grown graphene.[1] Cobalt and cobalt-platinum bimetallic particles were vapor deposited on supports under controlled vacuum conditions. The interaction between the graphene-covered support and the metal particles was investigated under vacuum and ambient pressure O_2 and H_2 in a wide temperature range (30-450 °C) using mainly Raman, X-ray photoelectron (XPS) and ion scattering (ISS) spectroscopies, as well as atomic force microscopy (AFM). We demonstrate that the graphene inter-layer significantly influences the oxidation state of both mono and bimetallic Co-Pt as compared to the one after direct deposition on bare oxides. In particular, Co interacts with oxide substrates forming flat particles which are partially oxidized upon annealing. This interaction can influence the morphology of CoPt by diffusion of Co at the subsurface leaving Pt dominating the surface of the particles. Insertion of a graphene interlayer between the metal overlayer and the oxide support, leads to the formation of highly dispersed Co and Co-Pt nanoparticles, which are resistant to oxidation, but prone to surface diffusion and agglomeration. These results explore new directions for the possible future use of graphene as a promoter in catalytic reactions.

References

(1) Luo, W.; Doh, W. H.; Law, Y. T.; Aweke, F.; Ksiazek-sobieszek, A.; Sobieszek, A.; Salamacha, L.; Skrzypiec, K.; Machocki, A.; Zafeiratos, S. *J. Phys. Chem. Lett.* **2014**, *5*, 1837–1844.

Figures

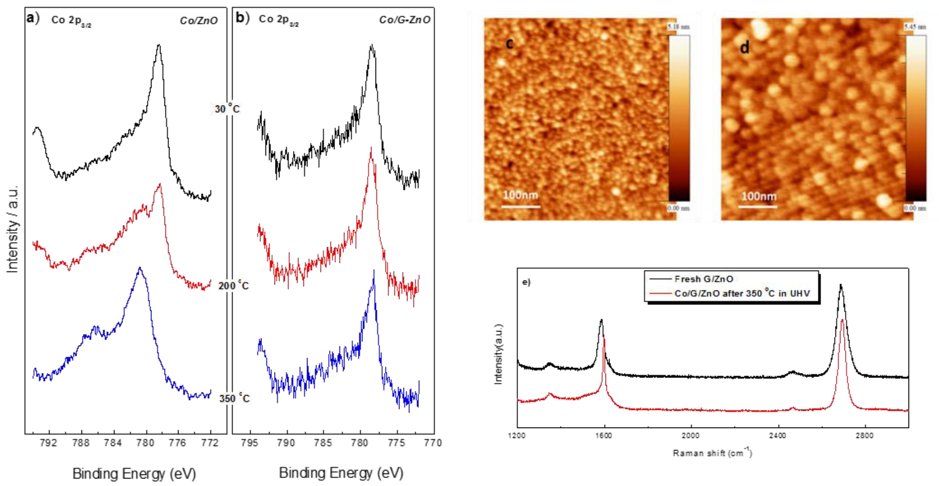

Figure 1: *(a,b) XPS spectra of (a) Co/ZnO and (b) Co/G-ZnO upon annealing at different temperatures. (c) Tapping mode AFM topographic images (500 x 500 nm^2) of fresh Co/G-ZnO and (d) Co/G-ZnO after annealing at 350 °C. (e) Raman spectra of fresh G/ZnO and Co/G-ZnO after annealing at 350 °C.*