Noble Metal/Ceramic Composites in Flame Processes

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Noble metals on metal oxides play a major role in the performance of electrodes, catalysts and many other applications. Today, impregnation of noble metals on metal oxides is done in the wet phase involving multiple steps. The physicochemical nature of the support, the precursor and the reaction conditions influence the resulting noble metal particles size in those systems [1]. For every specific application the particle size and the metal/metal oxide interaction affect the performance of these nano-composite materials [2].

Recently, aerosol processes have been successfully used to produce platinum [3,4], palladium [5], silver [6] and gold [7] crystallites on Al_2O_3 [3,5], SiO_2 [7] and TiO_2 [4,6,7] in a single step.. The as-prepared materials exhibited a high external specific surface area (40 – 320 $m^2 g^{-1}$) [3-7] with a high degree of crystallinity and an excellent noble metal distribution [3-7] with metal particles smaller than 7 nm on the metal oxide [3-7]. This makes them attractive for reactions with mass transfer limitation and for high temperature applications. An intimate contact of the two particles was observed in HRTEM images [3-5,7]. For a specific metal oxide support the metal particle size is mainly dependent on its loading [3,7].

In this study, the role of the supporting metal oxide on the noble metal particle size was systematically investigated for the flame spray pyrolysis process. The materials were produced at fixed process conditions such as resident time of the particles in the flame, energy input, maximum temperature and cooling rate. Having the same surface area of the support and metal loading, the materials exhibited different noble metal particle sizes. A fundamental understanding of the mechanisms of metal particle formation in the flame and the effect of the metal oxide support is presented for the controlled production of a desired metal particle size. With these concepts the properties of the noble metal on the metal oxide support and the interaction with the support can be tailored for specific applications.

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