EEPP1173
Energy & Environment

Synthesis Of Transition Metal Nanoparticles Using Combustion Based Techniques

10.5339/qfarc.2014.EEPP1173

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Abstract

Solution combustion synthesis (SCS) is a widely used technique for synthesizing variety of high purity oxide nanoparticles. Two basic modes for combustion synthesis are the self-propagating high temperature synthesis (SHS) and Volume Combustion Synthesis (VCS). The first method is based on the reaction that is locally ignited by an external source (laser, tungsten coil etc) which ends up with an exothermic redox reaction in a self-sustained manner without requiring any further energy for the combustion. Second method is the uniform heating of the entire sample in a controlled manner using a constant heat until the reaction occurs simultaneously throughout the volume. SCS typically involved a self-sustained reaction in a homogeneous solution of oxidizer (metal precursor) and oxygen containing fuels (urea, glycine, hydrazine etc). The selection of fuel is based on the reactive groups such as amino, hydroxyl and carboxyl bonded to a hydrocarbon chain.

In our total work, we used two modes of synthesis: VCS and ILCS (impregnated layer combustion synthesis) to synthesize transition metal nanoparticles. The precursors used in this work were Nickel nitrate hexahydrate, Ni(NO3)2.6H2O, Copper nitrate hexahydrate, Cu(NO3)23H2O, Cobalt nitrate hexahydrate, Co(NO3)2. 6H2O and Glycine CH2NH2COOH. The ratio of metal nitrates and glycine were optimized to give pure metals of high surface area. The precursors were thermally analyzed using TGA/DTA to understand the metal phase development with increasing temperature. Phase Composition and average particle size were analyzed using XRD and the specific surface area of the synthesized particle was calculated using BET method, while its morphology was analyzed by SEM. The objective of our work is to synthesize nanoparticle with high surface area, selectivity and reactivity, which will be more suitable to be act as catalysts for electrochemical reaction in the conversion of CO2 to valuable products

The XRD calculations indicated crystallite size to be in the range of 8nm - 15 nm indicating small nanoparticles with high surface area suitable of catalytic applications. The XRD profile of Copper-Nickel in glycine for different stiochiometric ratios shows the presence of pure alloy of Copper Nickel at its higher value of ϕ, say it as 1.75.

The multiple peaks in XRD for its lower stiochiometric ratio indicates the presence of oxide. The objective of our work is to synthesize nanoparticle with high surface area, selectivity and reactivity, which will be more suitable to be act as catalysts for electrochemical reaction in the conversion of CO2 to valuable products The large surface area for Copper Nanoparticles were synthesized first which having large surface active sites, they become excellent catalysts in metallurgical and petrochemical Investigation has been done based on the basic mechanism to describe the phase transformation in the combustion front. The SEM analysis pointed a remarkable change in the particle distribution, grain size, porosity and its microstructure by changing the oxidizer/ fuel ratio These nanoparticles are currently