5th International Conference and Expo on

Ceramics and Composite Materials

June 03-04, 2019 | London, UK

Polymer derived metal containing SiC(O)-based ceramic nanocomposites for methanation reaction

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Catalysis is a key technology to achieve the objectives of the challenge of "Going Green", as it helps to improve the environmental issues and save energy consumption in many of the chemical processes. Most of the catalyst are supported on porous materials, which help in improving the properties of a catalyst. SiC has already proved to be a very effective candidate as support in many chemical processes [2, 3]. However, commercialization of silicon carbide is still restricted due to limited specific surface area and homogeneous distribution of catalyst in it [4-6]. In the present work Si-M-C-based ceramic nanocomposites (M = Ni and Co) were synthesized upon the thermal transformation of single-source precursors, which were obtained by chemical modification of a polycarbosilane with metal acetylacetonate. High-temperature treatment of the precursor in argon atmosphere first leads to an amorphous SiMOC single-phase ceramic, which subsequently undergoes crystallization of metallic Ni and Co homogeneously dispersed within SiC(O) amorphous matrix. The specific surface area (SSA) of the obtained nanocomposite powders depends on the metal precursor and processing temperature. The SSA of SiC(O) increases from 5 to 250m^2/g by the chemical modification with metal acetylacetonate. The decomposition of the single-source-precursor helps to induce porosity in the final ceramic due to the evolution of CO_2, CH_4, H_2 etc whereas strong crosslinking with the help of metal acetylacetonate helps to retain it until high temperature. Nickel acetylacetonate was found to show a higher degree of the crosslinking of the precursor as compared to cobalt acetylacetonate, which in turn affect the SSA from 250 to 170m^2/g respectively. The SSA further decreases from 250 to 20m^2/g as the pyrolysis temperature increases from 600 to 1000°C, respectively. Preliminary results of the catalytic activity of the M/SiC(O)-based materials show that they are active for the methanation of CO_2. The maximum CO_2 conversion efficiency was found to be 50% at around 500°C for nickel based ceramic nanocomposites.

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