ABSTRACT

The thesis describes the author's attempts to develop the solution based chemical synthesis route (polymer precursor method) for the preparation of nanocrystalline powders of undoped c-ZrO_2, Y^{3+} stabilized c-ZrO_2, Cr^{3+}/Cr^{4+} stabilized c- and t-ZrO_2, Ta^{5+} stabilized t-ZrO_2 and Nb^{5+} stabilized t-ZrO_2. The effects of dopants on (i) nanocrystal formation and (ii) stabilization of high temperature metastable polymorphs of ZrO_2 have also been dealt with. The study provides some interesting informations regarding the effects of dopants like Y^{3+}, Cr^{3+}/Cr^{4+}, Ta^{5+} and Nb^{5+} on the stabilization of nanocrystalline c- and t-ZrO_2. This has been achieved by the use of polymer precursor method. In this method the metal ions are dispersed into the polymer matrix network in precursor solution. This on evaporation gives a highly porous carbonaceous precursor material. This is an amorphous material where the metal oxides are distributed in the form of clusters embedded in carbon matrix. During pyrolysis and calcinations of the precursor, the exothermic combustion of carbon helps the formation of nanocrystals of metal oxide. The polymorphic nature of ZrO_2, the morphology and microstructure of the nanocrystals have been studied elaborately with the help of TG/DTA, IR, UV-Visible, XRD and TEM.

The high temperature polymorph of zirconia (c-ZrO_2) has been prepared without dopant and this form transforms gradually and completely into m-ZrO_2 at the calcining temperature 1200°C. The formation of c-ZrO_2 is attributed to the structural similarity and its stability is attributed to critical particle size effect. Yttria stabilized c-ZrO_2 has been prepared with lower mol % of yttria compared to the reported methods. The c-, t- and m-ZrO_2 and their nanocomposites have been prepared with low mol % of Cr^{3+}/Cr^{4+}. This study indicates that Cr^{3+}/Cr^{4+} stabilizes zirconia by substituting Zr^{4+} in crystal network. Ta^{5+} and Nb^{5+} stabilized t-ZrO_2 have been prepared. The thermal stability of Nb^{5+} stabilized t-ZrO_2 is higher than Ta^{5+} stabilized t-ZrO_2.

Key words: Polymer precursor method, zirconia, nanocrystals, dopants, stabilization and effect of dopants.