

## Yttria nanopowders for transparent yttria ceramics prepared by precipitation sol-gel method

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Ce<sup>3+</sup>-doped Y<sub>2</sub>O<sub>3</sub> nanopowder was synthesized via precipitation method [1-2], using different molar concentrations of ammonium aqueous solution (0.5M, 1M, 1.5M) as precipitation agent. The aqueous nitrate solution of Y<sup>3+</sup> was prepared by dissolving yttria powders (99.99 %) in diluted nitric acid (HNO<sub>3</sub>) and deionized water under stirring and heating, then diluted into 0.1 M with deionized water. The solution of Ce<sup>3+</sup> was prepared by dissolving cerium nitrate (99.99 %) in deionized water and then diluted into 0.1M with deionized water. The mixed metal nitrate solution was dripped into ammonium solution, under continuous rapid stirring, ensuring there was sufficiently high excess of ammonia to eliminate any pH fluctuations throughout the process. The mixed solution turned to opaque white slurry. After 12 h aging the slurry was vacuum filtered through filtration paper and the resulting white precipitate was washed with distilled water, dried overnight in air at 100 °C, crushed and ground in an agate mortar and pestle, and calcined in air for 3 h at 700 °C (heating rate 10°C/min). Partly agglomerated powders with the primary size of Y<sub>2</sub>O<sub>3</sub> nanoparticles 55 nm and with cubic crystal structure were prepared. The optimum concentration of ammonia (precipitation agent) was found to be 0.5 M.

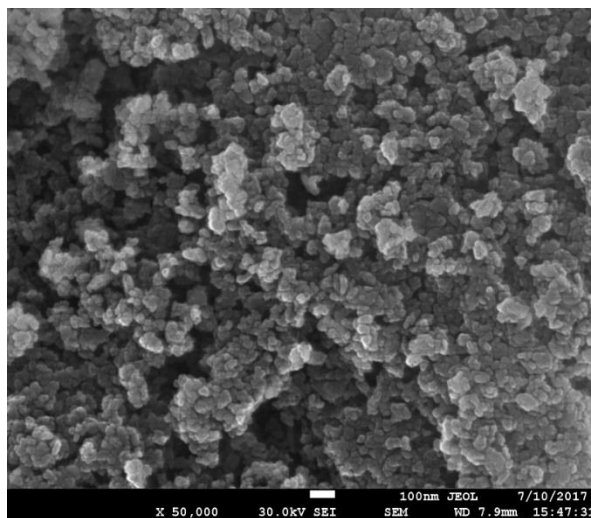


Fig 1. SEM micrograph of the prepared Y<sub>2</sub>O<sub>3</sub> powder

Ultrasonication (20 kHz) was then used to de-agglomerate prepared nanopowder in ammonium solution with pH value 11. Three different dispersants Dolapix CE 64, Darvan CN, and Polyethleneglycol (PEG) were tested, respectively. The particle size distribution and Zeta potential were determined as a function of sonication time and pH.

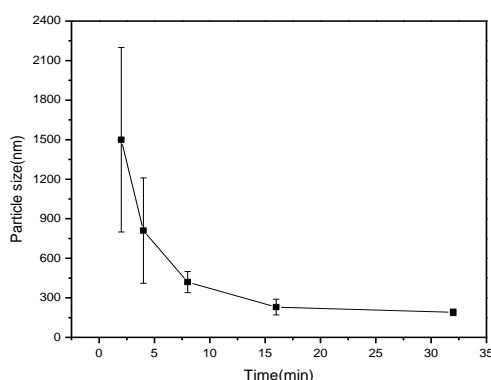


Fig 2. The change of particle size distribution of the Y<sub>2</sub>O<sub>3</sub> powder with the sonication time

Figure 2. summarizes the changes in particle size distribution of yttria powder with the sonication time. Extension of the ultrasonication time results in significant reduction of both the mean size of powder particles, and the width of the particle size distribution, indicating de-agglomeration of the yttria powder. The error bar on graph represents the particle size distribution at different time interval. The best results were achieved after 32 minutes' sonication time. However, the mean size of 200 nm clearly shows that the powder was not de-agglomerated down to primary particle size (50 nm), and hard agglomerates with the diameter of about 200 nm are still present.

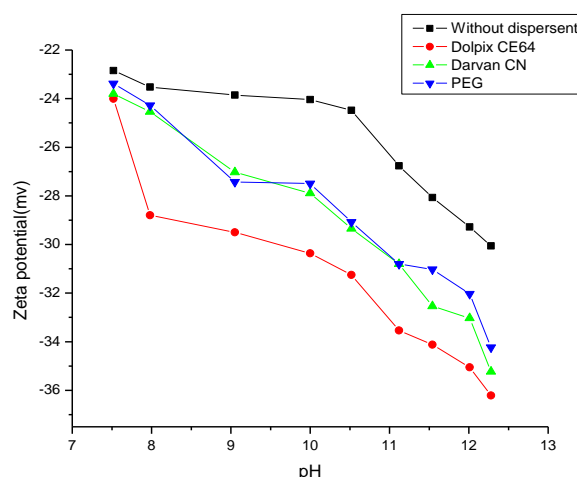


Fig.3. The results of Zeta potential of yttria suspensions with different dispersants

The zeta potential of  $Y_2O_3$  suspension with different dispersant (2 wt. % of Dolapix CE 64, PEG or Darvan CN) as a function of pH is depicted in Fig. 3. According to literature, the stability of the particles is achieved if the absolute value of the zeta potential is higher than 30 mV [3]. The ammonia-water based  $Y_2O_3$  suspension without dispersant shows zeta potential indicative values close to -30 mV. However, a suspension with a maximum zeta potential value of -36 mV was achieved when Dolapix CE dispersant was added. The results of sedimentation tests confirmed better stability of the suspension with added Dolapix CE64 dispersant compared to Darvan CN and PEG stabilised suspensions. Dolapix CE64 stabilized suspensions were selected for further experiments. Green compacts prepared by vacuum-pressure filtration at the applied pressure of 20 MPa with relative density 43 % were prepared.

Keywords: Transparent ceramics,  $Y_2O_3$ , Zeta potential

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