Synthesis of $\text{Y}_2\text{O}_3$ using a polyvinyl alcohol-assisted sol-gel route

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Yttrium oxide ($\text{Y}_2\text{O}_3$ yttria) is a well-known material with a wide range of technological applications. In this work $\text{Y}_2\text{O}_3$ nanoparticles were produced via PVA-assisted sol-gel method. PVA was chosen as the complexing agent due to some advantages, when compared to other routes, like a good stoichiometric control, relatively short production processing time at lower temperature and reduced costs. The pH control has been included as a variable parameter in the synthesis procedure aiming a better particle size control. The samples were prepared varying the pH of the starting solution in the range from near to 0 up to 3. The formed gels were dried out at $100^\circ\text{C}$ for 24 hours producing the xerogels for each pH value. Thermal analysis were performed to find the calcination temperature and, from that, temperatures between $600^\circ\text{C}$ to $1000^\circ\text{C}$ were tested, keeping the duration of the temperature plateau in 1 hour. The samples were heated up to the desired temperature following a heating rate of $10^\circ\text{C}/\text{min}$ and, after the temperature plateau, the samples were naturally cooled down to room temperature inside the muffle furnace. Results obtained from X-ray diffraction (XRD) technique were used to investigate the formation of the crystalline phase of the $\text{Y}_2\text{O}_3$ for the different synthesis conditions. Rietveld Refinement was applied to all XRD data to investigate the crystallinity degree of the samples. Furthermore, Williamson-Hall (W-H) formalism was applied in the Rietveld refinement data to investigate the crystallite size and lattice strain of the samples. The W-H plot shows a parabolic shape, indicating a non-homogeneous strain in the crystal lattice. These results also showed that this effect is highly influenced by the pH changes and synthesis temperature. The smallest crystallite size of about 11nm were obtained for samples calcined at $600^\circ\text{C}$ and starting pH3. (The authors acknowledge the partial financial support from CNPq, FINEP, CAPES and FAPITEC/SE funding agencies.)