URS 2022|UOJ
UNDERGRADUATE RESEARCH SYMPOSIUM 2022
PHYSICS SOCIETY
UNIVERSITY OF JAFFNA

Effect of ceria and yttria stabilizers on hydrothermal ageing resistance of two step sintered zirconia ceramics

Subasingha. G.B.S[1], Ng. C.K.[2], Ramesh.S[3], and Sutharsini. U[1]*.
[1]Department of Physics, Faculty of Science, University of Jaffna, Jaffna 40 000, Sri Lanka.
[2] Centre for Advanced Materials, Department of Materials Engineering, Faculty of Engineering and Technology, Tunku Abdul Rahman University College, 53300, Kuala Lumpur, Malaysia.
[3] Centre of Advanced Manufacturing and Material Processing (AMMP), Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603, Kuala Lumpur, Malaysia.
*ubsutharsini@univ.jfn.ac.lk

Abstract

Tetragonal zirconia exhibits excellent hardness and fracture toughness due to its transformation toughening mechanism. However, zirconia is susceptible to tetragonal to monoclinic phase transformation at low temperatures, which leads to microcracks and property degradation, a phenomenon known as low temperature degradation or hydrothermal ageing. Retention of tetragonal zirconia at room temperature is paramount for high toughness and can be achieved by the addition of stabilizers such as CaO, MgO, Y_2O_3 and CeO_2. In this study, hydrothermal ageing resistance of 3 mol.% yttria stabilized tetragonal zirconia (3Y-TZP) and 10 mol.% ceria doped tetragonal zirconia (10CE-TZP) were compared by using two step sintering method. 3Y-TZP and 10CE-TZP powder were uniaxial pressed and followed by cold isostatic pressing. Both samples were initially heated to 1500 °C and held at that temperature for one minute and then cool down to 1300 °C for 5 hours. Hydrothermal ageing was conducted for 36 hours in an autoclave containing superheated steam at 180 °C and 10 bar pressure. Phase transformation was analyzed by using X-ray diffraction (XRD) method.
It was found that the 10CE-TZP samples did not show any phase transformation within 36 hours of ageing. However, 3Y-TZP sintered with same profile exhibited the monoclinic phase formation within 1 hour of exposure. The figure below shows the XRD profile of both samples for exposure times up to 36 hours. The peak angle (2θ) around 30° belong to tetragonal and the peak around 28° belongs to monoclinic zirconia. It can be noted that as the ageing time increases, this was accompanied by an increased in the tetragonal to monoclinic phase transformation in the 3Y-TZP ceramics. This was not the case for the 10CE-TZP sample, thus indicating that the sintered ceramic was resistant against the aggression of water radicals in destabilizing the zirconia lattice and inducing the phase transformation.

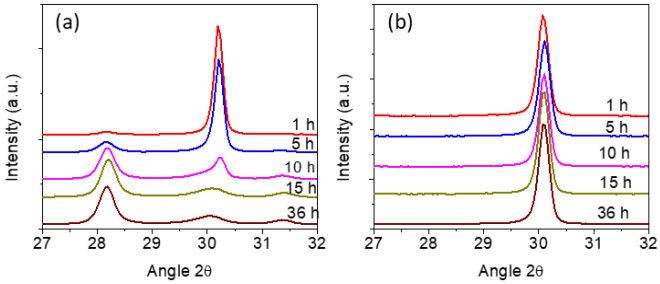

Figure: Effect of ageing time on tetragonal to monoclinic phase transformation **(a)** 3Y-TZP and **(b)** 10 CE-TZP