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POSITRON ANNIHILITION STUDY OF NANOSTRUCTURED ZrO_2

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The stabilized zirconia alloys have interesting mechanical and ionic properties which make possible to use it as structural and wear components, oxygen gas sensors, fuel cells etc.

In present work, Doppler broadening depth-resolved positron annihilation spectroscopy [1] was performed on pure zirconia nanopowders sintered in oxygen atmosphere. Zirconia nanopowders were grown by a hydrothermal microwave-driven process followed by annealing. To produce the mixture of tetragonal and monoclinic zirconia polymorphs, the obtained powder was annealed at 700 °C, a temperature found to be optimal from the point of view of the grain size and crystal structure (tetragonal one remains after cooling). In order to obtain monoclinic ZrO_2 nanopowder, the thermal treatment was conducted at 800 °C. Physical properties of obtained nanopowders (exhibiting the grain size of 20 to 40 nm, after annealing at 700-800 °C temperature, respectively) differ from those of bulk ZrO_2 due to, in particular, a large surface area.

Doppler-broadening spectra show low values of the normalized [1] S-parameter, varying little with the depth, from 0,495 on the surface to 0,47-0,49 in bulk. The higher annealing temperature and oxygen concentrations lead to lower bulk S-values. We studied also the positronium fraction from the 3-γ annihilation signal. Ortho-positronium fraction is about 10-11% for all samples on the surface, down to 7-8% in the bulk for samples annealed at 700 °C and 5-6% for samples annealed at 800 °C. Presence of ortho-positronium in nanopowders of ZrO_2 is also supported by lifetime measurement by Procházka et al. [2] who observed a long (34 ns) lifetime component with 6.4-7.4% intensity in similar samples.

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