Contribution ID: **149** Type: **not specified**

# TEMPERATURE INDUCED PROCESSES IN HE IRRADIATED BARIUM CERATE

Solid oxide ionic conductors with a perovskite structure are promising materials for use as electrolytes in fuel cells due to their unique properties. Among the currently known solid oxide proton conductors, doped barium cerates have one of the highest proton conductivities. However, the efficiency of fuel cells based on them is not high enough, which leads to the high cost of generated electricity. In order to improve the properties of these materials and increase the operating efficiency of electrochemical devices based on them, it is proposed to use various methods of modifying materials, in particular, irradiation with low-energy ions helium ions.
The paper presents the results of a study of the effect of irradiation with helium ions with an energy of 40 keV on the structure and properties of solid ceramic samples of barium cerate doped with Gd, Y and Nd (x = 10 and 15%). After synthesis, barium cerate samples were annealed in air at a temperature of 650℃ for 8 hours, and then irradiated with helium ions with an energy of 40 keV on a DC-60 accelerator. Helium ions were implanted on both sides of the samples to a fluence of 5×1016 cm-2 on each side.
Analysis of the elemental composition of the sample surface before and after irradiation revealed minor deviations from the initial stoichiometry depending on the type and level of dopant cation. It has been established that the implantation of helium ions into undoped barium cerates leads to homogenization of the surface composition of the samples. It has been shown that the surface of doped barium cerates is less susceptible to degradation upon implantation of helium ions than undoped ones, on the surface of which blistering is observed.
Using thermal desorption spectroscopy, the effect of helium implantation on the processes of water dissolution and proton intercalation in ceramic barium cerate was studied. It has been shown that the amount of desorbed water is minimal when barium cerate is doped with neodymium. It is assumed that the tendency of neodymium to exhibit mixed valence III/IV leads to a decrease in the concentration of oxygen vacancies involved in the process of water dissolution. Implantation of helium ions promotes an increase in the amount of dissolved water on barium cerate doped with Gd, Y and Nd, as well as an increase in the amount of desorbed oxygen in the case of neodymium.
Thermogravimetric studies have been performed on solid ceramic samples of barium cerate, subjected to pretreatment in different conditions: annealing of samples in air or vacuum, thermal cycling, and exposure at room temperature. It made possible to identify the features of the process of dissociative dissolution of water and filling of oxygen vacancies with hydroxyl groups, depending on the type of dopant cation and the level of doping. It has been shown that, as a rule, the degree of filling of vacancies is lower, than expected based on the doping level. It has been established that implantation of helium ions can have a significant effect on the intercalation of protons at certain stages of the water dissolution process.
Differential thermal analysis revealed several phase transitions that are observed in undoped barium cerate at temperatures of ~260, 390, 990 and 1030℃. After the dopant is introduced, the phase transitions disappear. Implantation of helium ions does not affect low-temperature phase transitions in BaCeO3, but extinguishes the high-temperature phase transition (1030℃), caused by the transformation of the tetragonal into cubic structure.
The work was carried out with the financial support of the Ministry of Energy of the Republic of Kazakhstan (PCF BR18574073).

## Section

Energy and materials science (Section 2)

**Primary author:** Dr KHROMUSHIN, Igor (Institute of Nuclear Physics of the Ministry of Energy of the Republic of Kazakhstan, Almaty)

**Co-authors:** Mr SLYAMZHANOV, Erasyl (Institute of Nuclear Physics of the Ministry of Energy of the Republic of Kazakhstan, Almaty); Dr AKSENOVA, Tatyana (Institute of Nuclear Physics of the Ministry of Energy of the Republic of Kazakhstan, Almaty); Mrs MIRMANOVA, Diana (Institute of Nuclear Physics of the Ministry of Energy

of the Republic of Kazakhstan, Almaty)

**Presenter:** Dr KHROMUSHIN, Igor (Institute of Nuclear Physics of the Ministry of Energy of the Republic of Kazakhstan, Almaty)

**Track Classification:** The V International Scientific Forum "Nuclear Science and Technologies": Energy and materials science (Section 2)