Contribution ID: **173** Type: **Poster**

Low-temperature phase transitions in PrAlO3–SrTiO3 series

Monday 17 September 2018 17:00 (15 minutes)

Phase and structural behaviour of the continuous perovskite solid solution Pr_{1-x}Sr_xAl_{1-x}Ti_xO₃ have been studied in the temperature range 20 –295 K by high-resolution X-ray synchrotron powder diffraction. Superb characteristics of the beamline ID22@ESRF allows to detect either subtle spiting of the main perovskite maxima and/or appearance of weak superstructure reflections, thus proving diverse variants of perovskite structure existing in Pr_{1-x}Sr_xAl_{1-x}Ti_xO₃ series at different compositions and temperatures. It was revealed that the samples with x = 0.1 and 0.2 undergo a sequence of structural phase transitions R-3c –Immb –I2/m, similar to those observed for the parent PrAlO₃ phase. These LT transitions in praseodymium aluminate are unique among all RAlO₃ perovskites and are considered to be caused by the electronic effects involving Pr³⁺ ions, e.g. a coupling between Pr³⁺ electronic states and phonons and/or cooperative Jahn-Teller effects. It was established that temperatures of both R-3c –Immb and Immb –I2/m transitions in Pr_{1-x}Sr_xAl_{1-x}Ti_xO₃ series systematically decrease from 205 K and 151 K for PrAlO₃ to 170 K and 90 K for x = 0.2 sample. Quite different phase behaviour was observed in the SrTiO₃-rich part of the system. Simultaneous aliovalent substitution of Sr²⁺ and Ti⁴⁺ species by 10 % Pr³⁺ and Al³⁺ ions increases the temperature of a Pm3m –I4/mcm transition from 105 K in SrTiO₃ to ~250 K in Pr_{0.1}Sr_{0.9}Al_{0.1}Ti_{0.9}O₃.

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Session Classification: Poster session 1

Track Classification: P8 Functional materials and materials science