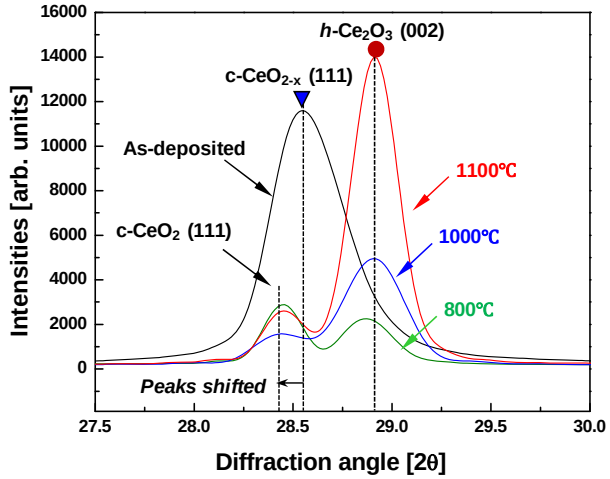
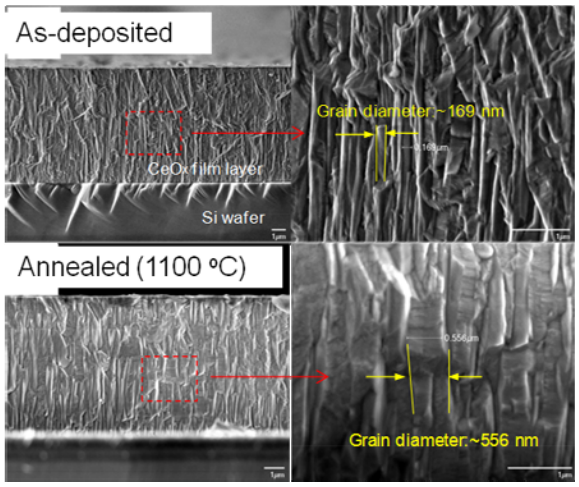
EFRC Center for Materials Science of Nuclear Fuel
Colorado School of Mines

Highlight: Effects of vacuum annealing temperature on the phase structure and grain growth of CeO_2 thin films





EFRC researchers **In-wook Park** (Postdoc) and **Jianliang Lin** (PI) at the Colorado School of Mines have investigated the effects of vacuum annealing temperature on the phase structure and grain growth of CeO_2 thin films.

The figure on the left shows the XRD patterns of CeO_{2-x} thin films before and after annealed at different temperatures. The as-deposited film exhibited a single cubic CeO_{2-x} (*c*-CeO_{2-x}) phase with a preferred (111) orientation without any hexagonal Ce_2O_3 (*h*-Ce_2O_3) peaks. As annealing from 800 to 1100℃ in the vacuum, the main peak separated into two peaks which correspond to *c*-CeO_{2-x} (111) and *h*-Ce_2O_3 (002) phases. The *h*-Ce_2O_3 (002) peak intensity gradually increased with an increase in the temperature. This phase transition from *c*-CeO_{2-x} (111) to *h*-Ce_2O_3 (002) can be explained by the Ce^{4+} to Ce^{3+} cation transformation due to the formation of oxygen vacancies. Additionally, the c-CeO_{2-x} (111) peak shifted to a smaller diffraction angle due to the lattice relaxation and the release of the residual stress at elevated temperatures. A continuous increase of the annealing temperature can promote *h*-Ce_2O_3 grain growth.

The figure on the right shows the cross-sectional SEM micrographs of the as-deposited CeO_{2-x} films and the film after annealing at 1100 ℃. The as-deposited film exhibited a columnar-type structure with a measured grain diameter of about 169 nm. After annealing at 1100℃, the size of the *h*-Ce_2O_3 grains increased to 556 nm.

This work has been presented at the 38th and 39th International conference on Metallurgical Coatings and Thin Films (2011 and 2012) in SanDiego, CO. A manuscript based on this work has been submitted to *Surface Coatings and Technology*. A manuscript is being prepared for submission to *Journal of Crystal Growth*.