PREPARATION OF THIN Gd_2O_3 FILMS BY RAPID EXPANSION OF SUPERCRITICAL WATER

Molnár P.[1], Jeppson P.[1], Brand I. J.[1,2]

[1]*University of Nebraska-Lincoln, Nebraska Center for Materials and Nanoscience, NE 68588-0511, Lincoln, USA*
[2]*Corresponding author: phone: 402 472 9320, Fax: 402 472 4732 email: jbrand@unl.edu*

Fabrication of thin films of gadolinium oxide was performed by partial dissolution of the metal oxide in supercritical (SC) water and subsequent free jet expansion of the solution. The studied novel approach has potential applications in the preparation of semiconductor devices.

The experimental setup used for depositing Gd_2O_3 films consist of HPLC pumps, an electrical furnace, a thick wall stainless steel coil, a dissolution chamber loaded with powder metal oxide and an aperture disk. Substrates, such as p-type Silicon (100) wafers or metal (Ni, Cu, Ag, Ni) plates were positioned in the free jet area.

The pressure (P) of the continuous water flow was varied between 240 bar <P< 400 bar, whilst the temperature (T) values were ranging between 400 ºC<T< 500 ºC, resulting the density of the supercritical water to be in the 0.1 g/ml – 0.3 g/ml range.

Depositions of Gd_2O_3 on substrates were performed either at atmospheric pressure or under vacuum, thus providing different growth conditions. The dissolution of the gadolinium oxide was estimated by a thermodynamic model at different processing conditions as well.

Samples of Gd_2O_3 films were characterized by a number of techniques, such as transmission electron microscopy, scanning electron microscopy, X-ray diffraction, X-ray photoelectron spectroscopy or atomic force microscopy.

Under these processing conditions, film growth rates of few nanometers per minute was observed. The analytical methods confirmed that depositions via supersonic expansion of supercritical water solutions provide highly oriented films of cubic Gd_2O_3. Current – bias measurements confirmed the semiconductor nature of the prepared samples, proving the efficiency of the applied supercritical water expansion method in the field of preparing electronic devices.

The research work was supported by the Defense Threat Reduction Agency, USA; and the Rosztoczy Foundation.