

Thesis Abstract

This thesis reports on deposition and characterization of yttrium oxide and yttria stabilized zirconia coatings. These coatings are deposited using capacitively coupled radio frequency plasma assisted chemical vapour deposition process using metalorganic precursors.

Yttrium oxide thin films have been deposited using (2,2,6,6-tetramethyl-3,5-heptanedionate)yttrium [$Y(\text{thd})_3$] precursor under the varying influence of RF self bias (-50 V to -175 V) on the substrate during deposition. Effect of RF self bias during deposition on the properties of the yttrium oxide films is studied with help of different characterization techniques such as grazing incidence x-ray diffraction, fourier transform infrared spectroscopy, X-ray photoelectron spectroscopy, field emission scanning electron microscopy and spectroscopic ellipsometry. A strong correlation is observed between the self bias on the substrate during deposition and properties of the deposited films. The structure of the films change from microcrystalline to nanocrystalline / amorphous with increase in bias. All the films are optically transparent within a wavelength range of 300-1200 nm. The refractive index is enhanced for the nanocrystalline film. Beyond -125 V self bias there is increase in nucleation density leading to nanocrystalline structure. Such a systematic study on variation of properties of the deposited films with variation of bias is not reported so far. Extended X-ray absorption fine structure (EXAFS) analysis is done on the deposited samples and correlation of variation of bias with local structure is reported for the first time. EXAFS analysis is further useful in understanding change in properties of films with bias and variation of bond length, co-ordination number could be correlated to results obtained by other characterization techniques.

Yttria stabilized zirconia thin films are deposited using octanedionate precursors under the influence of RF self bias (- 100 V) on the substrate during deposition. A (2, 7, 7-trimethyl-3, 5-octanedionate) yttrium (known as $Y(\text{tod})_3$) and (2, 7, 7-trimethyl-3, 5-octanedionate) zirconium (known as $Zr(\text{tod})_4$) are used for the first time for deposition of yttria stabilized zirconia coatings. Three different films are deposited by varying the yttria content in the films (4, 5 and 9 mol %). A detailed study on structure of films is done using characterization techniques such as grazing incidence x-ray diffraction, fourier transform infrared spectroscopy, X-ray photoelectron spectroscopy, field emission scanning electron microscopy, atomic force microscopy, energy dispersive X-ray analysis and spectroscopic ellipsometry. Synchrotron based techniques such as X-ray near edge absorption fine structure (XANES) and Extended X-ray absorption fine structure (EXAFS) are used to study the local structure of the deposited films. The optical properties are found to be dependent on the structure of films and are enhanced for nanocrystalline structure. The tribological investigations through scratch adhesion testing and determination of friction coefficient indicate that the film with 4 mol % yttria is more resistant to crack and wear as compared to the other two films. The observed properties of the films are explained in terms of phases present (monoclinic, tetragonal and cubic) in the films.