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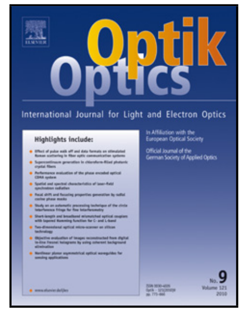

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Authors: I.O. Olarinoye, F.O. Ogundare

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Optical and microstructural properties of neutron irradiated RF-sputtered amorphous alumina thin films

I. O. Olarinoye[a] and F. O. Ogundare[b]
[a]Department of Physics, Federal University of Technology, Minna, Niger state, Nigeria
[b]Department of Physics, University of Ibadan, Ibadan, Oyo state, Nigeria
E-mail:lekeola2005@yahoo.com; olarinoyeleke@gmail.com; leke.olarinoye@futminna.edu.ng

Abstract

Stoichiometric amorphous aluminium oxide thin films were deposited on glass substrate by the reactive sputtering technique. The films were exposed to varying thermal neutron fluence ranging from 6×10^{12} neutron/cm^2 — 4×10^{13} neutron/cm^2. The radiation induced changes in the structural, surface structural, and optical properties were investigated using X-ray diffraction, atomic force microscopy, and the UV-VIS spectrophotometric analysis respectively. The structural phase of the film was not altered after irradiation, however, surface roughness parameters increased with neutron fluence. Empirical expression relating neutron dose and films' roughness were also derived. Furthermore, the optical transmittance, absorption and other related optical constants were affected by the neutron radiation. Possible reasons for the variations in optical properties of the films as a function of neutron fluence were discussed.

Keywords: Alumina; Thin film; Neutron; Optical constants; Radiation; Surface roughness

1. Introduction

Aluminium oxide has been reported to be the most cost effective and commonly used engineering ceramics [1]. Alumina exist in seven (α, β, γ, η, θ, κ, χ) crystallographic polymorphs [2]. However, the α-phase of alumina is the most stable thermodynamically while others emerge at different temperatures below 1073 K [3]. The amorphous phase of alumina has never been obtained in bulk form but exist in thin film at lower temperature of deposition. This low temperature requirement for its deposition has made deposition of alumina on temperature sensitive surfaces attractive. Amorphous alumina has been deposited on different substrates using different deposition techniques [4-22]. Alumina thin films have wide range of applications due to their excellent optical properties. Their optical transparency in the VIS-IR region of the electromagnetic spectrum, wide optical band gap, high dielectric constant and refractive index [6, 23-27] have made them good candidates for many applications. These optical properties are the reasons alumina films are used in optoelectronic devices, passivation of metal surfaces and Si solar cells, wave guides, organic light emitting devices, solar selective coatings, anti-reflectance coatings, optical lenses and windows [28-34]. Consequently, research into alumina thin film has been very active. Furthermore, the microstructural and optical properties of films deployed for optical applications depend on the deposition parameters and may also be affected by extreme (operational) environmental factors. It has been established [35-37] that exposure of optoelectronic devices to ionising radiation accelerates aging due to radiation induced