INVESTIGATION ON THE COATING OF HIGH REFRACTIVE INDEX QUARTER-WAVELENGTH THICK ZIRCONIUM AS A MATERIAL LAYER FOR DIELECTRIC MIRROR

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ABSTRACT

Sol gel method for the preparation of ZrO_2 thin film using zirconium oxychloride as the starting precursor. Thin films were deposited using dip-coating method onto silicon wafer and glass substrate. The dip-coating rate was varied from 10mm/min to 40 mm/min to obtain the exact thickness of 71.5 nm as one-quarter wavelength. The surface morphology, crystalline structure, optical properties, thickness and refractive index of ZrO_2 thin film were investigated by using AFM, XRD, Uv-Vis, Surface Profiler and Prism Coupler measurement. The average surface roughness of ZrO_2 thin film is about 2 nm respectively. The films present a tetragonal phase for annealing temperature 500°c. A large percent of transmission approximately 90% was present for fast dip-coating rate and very low dip-coating rate have percentage of transmission below 70%. At the dip-coating rate 10mm/min, the exact thickness of 72 nm was achieved. However, the crack formation of one layer of ZrO_2 thin film was observed. Refractive index that characterize by prism coupler using wavelength, λ = 632nm give high refractive index for ZrO_2 (2.07 -2.15).

Keyword: sol-gel technique; dip-coating thin films; Zirconium oxide (ZrO_2); refractive index

CHAPTER 1

INTRODUCTION

1.1 Background of study

Mirrors commonly have a metallic coating [1] with silver (Ag) or gold (Au) which can conduct electricity. It is harmful to laser application but it is the cheapest compared other optical coating. Different from metals, dielectric mirror can reflect light more efficiently because it does not conduct electricity. Dielectric mirror is composed of multiple thin layers of dielectric materials with a high refractive index interleaved with layers of low refractive index [2]. For example, ZrO_2 is used for high refractive index and SiO_2 for low refractive index[3,4]. The result is high-performance mirrors that can achieve reflectivities approaching 100 percent for critical imaging and laser applications. In addition, dielectric coatings are far more durable than metallic coatings, low cost and high reflectivity that is useful in application laser. Dielectric mirrors can be fine-tuned to reflect specific wavelengths by trimming the thickness of each layer so that the product of the thickness and refractive index equals one-quarter of the target wavelength. This type of coating is termed a quarter wavelength stack reflector. Increasing the number of layers can increase the reflectance for specific wavelengths, but often at the expense of spectral bandwidth. Another drawback is that dielectric mirrors are often very sensitive to the angle of incidence and can produce undesirable plane-polarized light when incorrectly positioned.