MECHANICAL AND OPTICAL PROPERTIES OF NANOSTRUCTURED THIN FILMS FABRICATED BY OBLIQUE ANGLE DEPOSITION

by

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A Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the degree of

MASTER OF SCIENCE

Major Subject: MECHANICAL ENGINEERING

Approved:

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August, 2011

ABSTRACT

The history and employment of thin films are reviewed in the first part of this Master-of-Science thesis. After that, a major technique, oblique angle deposition (OAD), which can be used to deposit thin films, is introduced. This technique shows great potential for applications in industry.

The primary objective of this thesis is to find materials that can be used to fabricate a nanostructured thin film with elastic properties. Therefore, the mechanical properties of nanostructured thin films need to be measured.

In order to investigate the mechanical properties of nanostructured thin films which are deposited with the OAD technique, the nanoindentation method is employed to measure nanorod thin films that are composed with different materials. Finally, the refractive index and porosity of Ge thin films are studied.

Chapter 1 gives a brief introduction to thin film fabrication history and different techniques to obtain porous thin films. We show that physical vapor deposition (PVD) is a fast and efficient deposition technique that is broadly employed to fabricate thin films.

Chapter 2 discusses one important PVD techniques, the oblique angle deposition (OAD) method, which is employed to deposit all thin films consisting of nanorods in this thesis work. The relationship between thin film deposition angle α and nanorod tilt angle β, measured by a scanning electron microscopy (SEM) is illustrated and established. In the meantime, the key parameters used to do deposition are also provided in this chapter.

At the beginning of Chapter 3, the mechanical properties and measurement methods of a nanorod thin film, discussed in the literature, are introduced. Thereafter, the main method, the nanoindentation measurement, which can be employed to measure elasticity of thin films, is discussed. Next, the measurement results of nanorod thin films that are composed of Ge, ZnSe and CaF_2 materials are shown to demonstrate that Ge is a good choice to satisfy our goal. In order to further investigate the elastic property of Ge nanorods, cycles of nanoindentation of different deformation are done.

In Chapter 4, basic interference theory is introduced, which is employed as the theory of refractive index measurements. The refractive index for porous Ge thin films can be achieved by matching the experimental measurements with the theoretical model.