Elastodynamics of Inorganic and Polymeric Sculptured Thin Films

Akhlesh Lakhtakia

Pennsylvania State University

Department of Engineering Science and Mechanics, 212 EES Building,

University Park, PA 16802-6812, USA

Sculptured thin films (STFs) are nano-engineered, porous, solid thin films conceptualized in the early 1990s and fabricated by several research groups since then [1]. The nanostructure of inorganic STFs typically comprises 1-3 nm dia clusters arranged to form parallel nanowires that are bent in some fanciful forms with feature size 30 nm or larger. Although most STFs are made of inorganic materials, some polymeric STFs have also been fabricated in recent years.

The Mori-Tanaka average stress and the Eshelby tensor for ellipsoids has been used within the framework of localized homogenization in order to estimate the elastic constitutive properties of an STFs from its morphology. The devised model contains five arbitrary parameters, whose values can be decided by suitable experimentation. Composite compliances governing the elastostatic and the elastodynamic responses of chiral STFs to axial excitation depend on certain morphological features, as also are the characteristics of the polarization-discriminatory Bragg phenomenon associated with chiral STFs.

The optical properties of polymeric STFs can be controllable piezoelectrically. This is exemplified by the shift of the Bragg center-wavelength of a polymeric chiral STF by the axial tension generated in a co-bonded piezoelectric disk by a dc voltage. This attractive possibility can be exploited for tunable optical filters as well as lasers made of chiral STFs, and can be extended to other types of STFs.

Keywords: Bragg phenomenon, local homogenization, piezoelectric control, sculptured thin films, structural chirality, tunable optics

References

[1] A. Lakhtakia and R. Messier, *Sculptured Thin Films: Nanoengineered Morphology and Optics*, SPIE Press, Bellingham, WA, USA (2005).

Topic: Thin Films