MECHANICAL BEHAVIOR OF OPTIMIZED OPTICAL NANOMULTILAYERS

Danielle E. White, University of Southern California
dewhite@usc.edu
Edoardo Rossi, University “Roma Tre”
Marco Sebastiani, University “Roma Tre”
Andrea M. Hodge, University of Southern California

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Ceramic nanomultilayers, which are layered thin films of alternating materials, were selected for their inherent optical performance in the ultraviolet, visible, and near-infrared (UV/Vis/NIR) wavelength range. AlN/Al_2O_3, TiO_2/SiO_2, and AlN/SiO_2 multilayer systems were optimized via calculations to tune the individual layer thicknesses for improved optical transmittance. Microstructural and interfacial changes such as variations in grain morphology and interface structure were shown to depend on layer thicknesses and composition. Mechanical behavior of the optically optimized nanomultilayers was tested in both compression and tension to understand the baseline relationship between optical and mechanical performance. Techniques ranging from nanoindentation to microtensile testing were used to ascertain properties such as hardness, fracture toughness, elastic modulus, yield strength, and % elongation for analysis with respect to the film’s optical configurations. Overall, the optically optimized AlN/Al_2O_3 system, having a crystalline/amorphous interface, demonstrated the best mechanical performance amongst the three systems, while the behavior of the optically optimized TiO_2/SiO_2, having an amorphous/amorphous interface, was found to be lowest.