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Controlling refractive index in AlN films by texture and crystallinity manipulation

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Abstract:

Highly textured polycrystalline aluminum nitride (c-AlN) thin films with hexagonal wurtzite structure have been prepared by direct current reactive magnetron sputtering (DC) of pure aluminum using different compositions of the gas phase and different substrate temperatures. The structure and the microstructure of the films have been investigated by x-ray diffraction (XRD) and transmission electron microscopy (TEM). In addition, the complex refractive index dispersion $\bar{N}(\lambda) = n(\lambda) + jk(\lambda)$ of the films and their thickness have been determined from the normal-incidence transmittance spectra measured in the UV and visible regions. An increase in the XRD intensity of (002) planes associated with the nitrogen contents in the gas composition has been observed. It was found that higher nitrogen content in the gas phase mixture and higher substrate temperature help to improve the preferred orientation of the coatings along the *c*-axis of the wurtzite cell. This is accompanied by an increase of the ordinary refractive index (n_0) from 1.8 to 2.1. This can be attributed to the reduction of the lateral defect density between the columns' interfaces in highly textured samples, which is in line with the TEM observation that shows well aligned columns in the sample with highest ordinary refractive index. ~~which is consistent with Consistently with the hypothesis that improved preferential crystallographic orientation enhances the dipole alignment along that direction. lead to decrease the density of defects owing to the better columnar alignment~~.