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Structure-property correlations in reactively sputtered Al-Ge-O-N thin films

Kristina Johansson, Erik Lewin

Uppsala University, Uppsala, Sweden

kristina.johansson@kemi.uu.se

Coatings consisting of Al, Ge, N and O have been deposited using reactive DC magnetron sputtering in order to study the correlations between structure and properties. In a previous study of ternary Al-Ge-N thin films, it was found that the optical bandgap could be tuned through variation of Ge content. Due to weak Ge-N bonds this material is metastable. A possibility to increase the stability would be to substitute N with O. Thus, the aim of the present study is to investigate the effect of alloying Al-Ge-N thin films with oxygen and it is the first study of the Al-Ge-O-N material. The oxygen and germanium contents were varied by changing the amount of O2 in the reactive gas flow and the target power of Ge respectively. The films were analyzed using X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), UV-vis spectroscopy and nanoindentation. Coatings with up to about 20 at.% oxygen and up to about 15 at% germanium were deposited. Generally, a wurtzite type AlN phase was observed, indicating a (Al1-xGex)(N1-yOy) solid solution phase. Crystallinity was found to decrease with increasing oxygen and germanium contents, resulting in X-ray amorphous coatings at high alloying levels. The hardness decreased by the addition of oxygen, from 17 to 9 GPa. The optical absorption edge shifted to lower wavelengths with increasing oxygen content, 323 to 294 nm. The combination of these properties, i.e. the observed variation of the absorption edge and the relatively high hardness indicates that these materials could be interesting as multifunctional coatings.

Keywords
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