Study of AlN-ScN thin films for piezoelectric energy harvesters

Semester project

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Piezoelectric AlN (aluminium nitride) thin films were commercialized about 15 years ago, and are found today in every smart phone serving as resonating structures in radio frequency (RF) filters. The polar structure (wurtzite phase) can conveniently be grown in (0002) texture, whereby the polar, hexagonal c-axis is pointing in the same direction for all the grains. Some years ago, it was discovered that one can “alloy” AlN with ScN (scandium nitride). Although the latter is a non-polar rocksalt structure, one can substitute up to about 40% of Al by Sc, and still obtain the piezoelectric wurtzite structure. The large interest in this alloy is the fact that piezoelectric coefficients rise with increasing Sc content.

The content of the work is to deposit such AlScN films by a double source DC-sputtering confocal technique from two elemental targets (Al, Sc) in Ar+N2 gas (reactive sputtering). The 4-inch substrate is not rotated, meaning that films with a compositional and thickness gradient are deposited. The goal is to locate as sharply as possible by XRD-investigations the boundary between wurtzite and neighbouring phases (morphotropic phase boundary) as a function of deposition process parameters, such as temperature and applied powers. One task is to analyse crystalline phase microstructure by SEM/TEM and their dependency on the film composition. As a second task, the functional piezoelectric and dielectric properties of the films should be measured.