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Reactive pulse magnetron sputter deposition of piezoelectric AlN layers

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Reactive pulse magnetron sputtering of Al targets in a gas mixture of Argon and Nitrogen allows the deposition of AlN layers at high deposition rates up to 200nm/min. In the reported experiments films were deposited onto unheated substrates with a thickness of typically 10µm. Deposited films have been characterized for a variety of deposition parameters using XRD, SEM, profilometry, weighting and piezoelectric measurements regarding crystalline structure and orientation, surface morphology, density, film stress and piezoelectric coefficient d_{33}. The characterized AlN films can be classified into 2 groups. The first group shows a nearly pure 001 orientation of the crystalline structure, an undisturbed surface morphology, a high density and a very high piezoelectric coefficient d_{33} of up to 8pm/V. The second group exhibits a dominating but not pure 001 orientation, disturbances in the surface morphology, a slightly lower density and a piezoelectric coefficient close to zero. The range of the process parameters pulse mode, pressure, sputtering power and reactive working point to achieve the layers of the first group is very narrow. Surprisingly films with high piezoelectric constant can be obtained both by strong and moderate particle bombardment during deposition using adapted parameter sets. Examples of application of the films are given.

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