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Electronic properties of thin AlN films deposited by magnetron sputtering method on silicon substrates

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Such properties of the AlN films as e.g., isomorphous crystallographic structure, high resistivity (~10^{13} Ω cm), high thermal stability (up to 2200 °C) or high thermal conductivity (~320 W/mK), make this material excellent for application in structure of HEMT, transistor playing role of gate dielectric.
The AlN films were deposited using magnetron (fi = 100 mm) and pulse power supplier (f = 100 kHz, with modulation of f = 2 kHz; current from 2 to 8 A). Deposition processes were carried out at pressure of 10 Pa and using Ar/N_2 gas mixture. The films were deposited on p-type silicon wafers located in parallel to aluminum target, keeping substrate-target distance at 7 to 15 cm.
Round, aluminum (Al) electrodes were evaporated on the top of deposited layers. Thus, metal-insulator-semiconductor (MIS) structures were created with aluminum nitride thin films (30 - 200 nm) playing the role of the insulator. Measurements of current-voltage (I-V) characteristics of MIS structures, allowed to determine that the leakage current density and critical electric field intensity (E_{BR}) of investigated layers ranged from 10^{-9} to 10^{-8} A cm^{-2} and from 3,6 to 4,4 MV cm^{-1}, respectively. Capacitance-voltage (C-V) measurements of the same structures were performed in accumulation state showing that the dielectric constant value (ε_{ri}) of films is of the order of 5 to 6.5.
Ellipsometric measurements allowed to obtain properties of deposited layers like thickness (30 - 200 nm), refraction index (estimated between 1,650 and 1,937) and energy band gap (equal from 4,245 to 6,432 eV).
AlN layers were selective etched in different concentration of hydrofluoric acid. The influence of etching mixture on etching progress and the state of exposed Si surface was subsequently studied and is discussed.
Films' microstructure and composition were additionally studied using scanning electron microscope (SEM), transmission electron microscope (TEM), X-ray diffraction (XRD) and X-ray photoelectron spectroscopy(XPS).

Keywords
magnetron sputtering
aluminum nitride thin film
electronic properties