Frequency Dependence of Wake-up and Fatigue Characteristics in Ferroelectric $Al_{0.93}B_{0.07}N$ Thin Films

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B-doped AlN ferroelectric thin films are promising candidates for non-volatile memory device applications, due to their relatively low deposition temperatures, large remanent polarizations (up to 120 μC/cm^2), and outstanding polarization retention properties. In this research, the polarization switching fatigue characteristics in epitaxial B-doped AlN thin films were investigated. Films were deposited via reactive RF magnetron sputtering onto W-coated *c*-plane sapphire substrates. Polarization switching fatigue measurements were conducted with triangular waveforms for frequencies between 50 and 1000 Hz from room temperature to 200°C. On repeated cycling, the films undergo wake-up; the wake-up process was characterized by an activation energy of 0.15 ± 0.05 eV. After a period of normal switching, the film leakage current increased with additional cycling, and finally the films underwent dielectric breakdown. Unpatterned $Al_{0.93}B_{0.07}N$ films with 100 nm thick Pt top electrodes survived $\sim 10^4$ bipolar cycles, whereas films with 1000 nm W top electrodes survived $\sim 10^5$ cycles before dielectric breakdown. Modeling was used to design a field plate, which improved the performance to $\sim 10^6$ fatigue cycles. It was found that dielectric failure during fatigue was not due to surface flashover but was associated with hard breakdown events in the dielectric. Failure for 100 Hz cycling was not associated with device self-heating but was exacerbated by field concentrations; at higher frequencies, the instantaneous temperature rise during the switching becomes prominent. Based on the fatigue process under 100 Hz under various ambient temperatures, the activation energy of the polarization switching fatigue of B-doped AlN thin films was found to be $E_a = 0.10 \pm 0.03$ eV.