Comparative study of AlN dielectric films' electrical properties for MEMS capacitive switches

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Aluminum nitride (AlN) piezoelectric thin films are very popular in RF micro-machined resonators and filters MEMS devices. The advantages of these films arise from their high resistivity and piezoelectric coefficient, which is the largest among nitrides, as well as the possibility of being deposited at temperatures lower than 500°C and patterned using conventional photolithographic techniques. AlN generally exhibits smaller piezoelectric and dielectric constants and differs from PZT materials in that it is polar rather than ferroelectric. Different techniques such as sputtering, metal-organic chemical vapor deposition (MOCVD), pulsed laser deposition (PLD), plasma enhanced chemical vapor deposition (PECVD) and molecular beam epitaxy (MBE) have been used so far in order to investigate and improve the properties of AlN films.

The present paper investigates and compares the electrical properties of aluminum nitride films deposited by different techniques. Metal-Insulator-Metal (MIM) capacitors with AlN films have been grown by magnetron sputtering and plasma - assisted molecular beam epitaxy (PA-MBE) methods. The sputtered AlN films were N face with a thickness of 200 nm while PA-MBE grown films had a thickness of 100 nm. The assessment is based on electrical characterization measurements obtained under vacuum and in a temperature range from 300 to 400 K.

The experimental data revealed the dominant conduction mechanism of the AlN films and it has been found that charge collection takes place through variable range hopping in the magnetron sputtered film while Poole-Frenkel effects dominate the conduction process in PA-MBE grown films. Moreover, charging and discharging processes have been found to obey stretched exponential law, in agreement to Kohlrausch-Williams-Watts polarization's relaxation, found in many disordered materials.

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