Magnetron Deposition of AlN and ScAlN for Mass-production for BAW Devices and MEMS

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Bulk acoustic wave (usually referred to as BAW, FBAR and SMR) filter devices used in cell phones have used piezoelectric AlN for more than a decade.

In the last few years new MEMS devices such as piezoelectric MEMS oscillators (also known as pMEMS) started using AlN in high volume products.

While it is no longer a great challenge to make limited numbers of wafers employing reactively sputtered piezoelectric AlN films suitable for BAW applications, there are several barriers to making them in a high volume.

Tight control of crystallinity, uniformity, deposition rate, coupling coefficient and stress through target lifetimes and across wafer are major barriers to high volume production. Independent control of AlN thickness and stress uniformity across wafer is critical for FBAR devices that require high coupling coefficient with tight distribution. Novel tool innovations have been successfully implemented to address these issues. Data from production tests show that *in-situ* laser interferometry thickness monitoring significantly reduces wafer-to-wafer thickness variations due target rate roll-off. Use of a unique local enhancement of the magnetron magnetic field to compensate for non-radial uniformity profiles eliminates changes induced by variations in target material as well as system asymmetry. In-situ ion beam milling dramatically improves thickness uniformity.

ScAlN deposition is used in applications requiring much higher coupling coefficient than AlN can produce. Although, similar to AlN deposition, ScAlN requires much more care to produce uniform films with good surface roughness and no surface defects sometimes called “crystallites”. Significant modifications to magnetic fields and ion mill trimming are used to create high concentration ScAlN films usable in filter and MEMS applications.