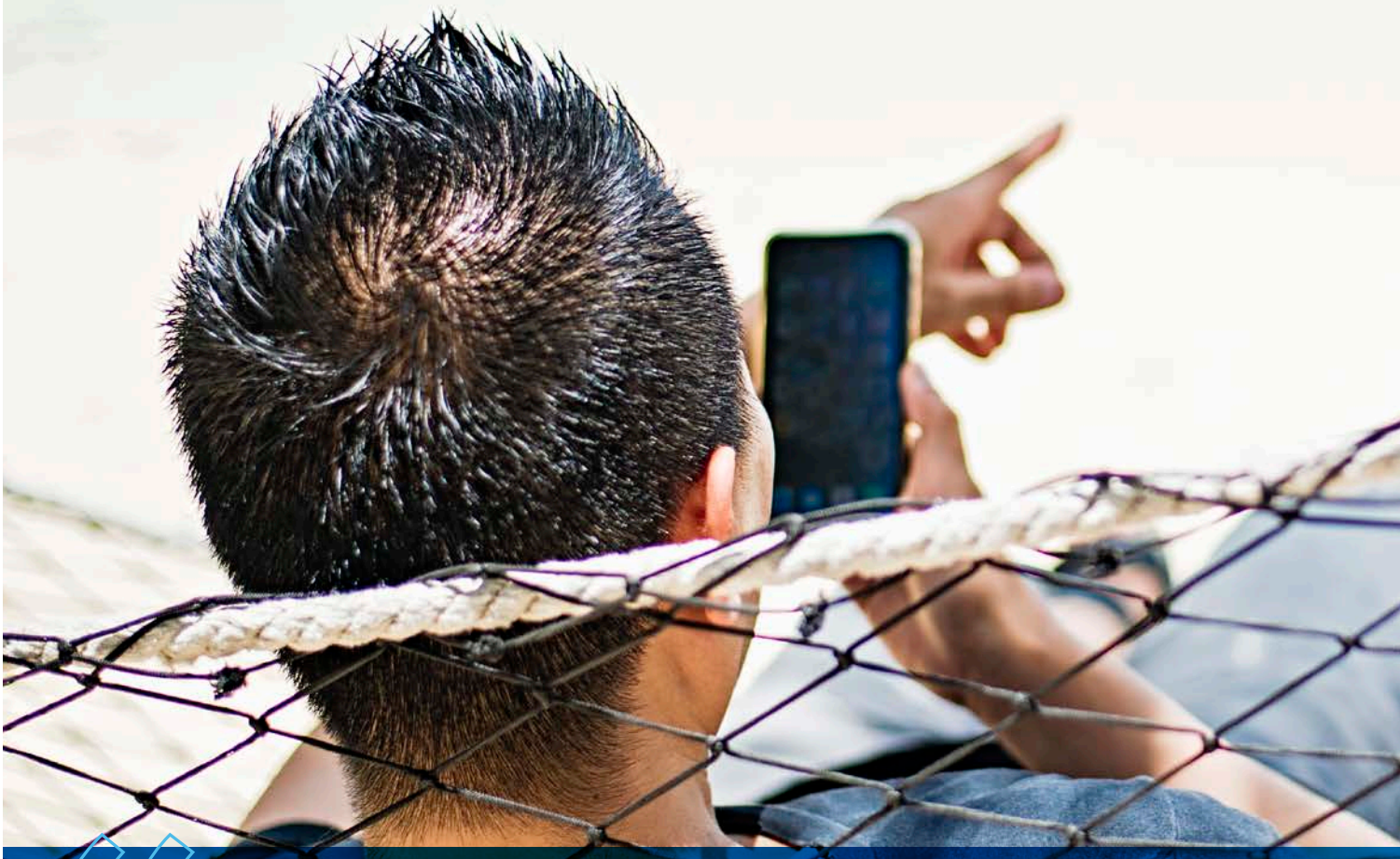
KEEPING STRESS UNDER CONTROL

BU Head, **Silvan Wuethrich** and Senior Scientist **Dr. Andrea Mazzalai** explain how advanced plasma intensity distribution control brings the superior "wafer-in-wafer" levels of stress uniformity required for BAW processes on 8 inch wafers.



CLUSTERLINE® 200 FOR AIN CAN NOW BRING THE COMBINATION OF WAFER-IN-WAFER THICKNESS AND STRESS UNIFORMITIES OF AL0.8SC0.2N THIN FILMS ON 8 INCH WAFERS TO AN UNPRECEDENTED LEVEL OF CONTROL

Getting the most from 5G

5G mobile communication may be just around the corner, but the full potential of the next generation of wireless devices will only be achieved once the frequency bands above 20 GHz can be exploited. This frequency requirement will push bulk acoustic wave (BAW) technology development towards the use of high Sc concentration Al1-xScxN films.

Together with overall enhancements in coupling coefficient itself however, this also brings increased sensitivity of coupling coefficient to film stress, creating the need for deposition processes with very tight wafer-in-wafer stress uniformity, and all without compromise in thickness variation.

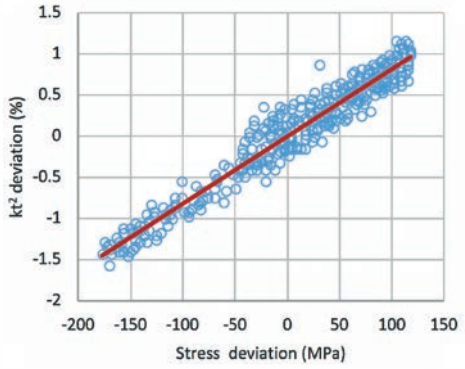


Figure 1. Deviation from average of the coupling coefficient as a function of Al0.7Sc0.3N thin film stress variation: the slope is steep and translates into 0.5% of coupling change every 50 MPa

Solving the production challenge

For PVD processes this represents a great challenge, as the finite nature of the target requires larger plasma intensity at its edges to ensure adequate thickness distribution. If uncontrolled, this in turn creates an increase of the ion bombardment at the wafer edges which is responsible for a compressive dropdown of the stress in conventional DC-pulsed processes.

The obvious solution is to employ a larger target surface, but this has a seriously detrimental impact on the cost of ownership due to target manufacturing costs.

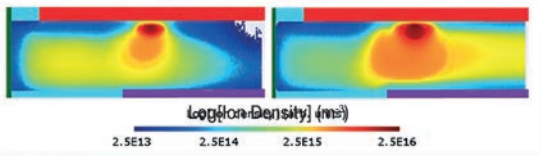


Figure 2. Plasma density obtained from simulations for two different RF-DC parameters: we can shape the plasma in order to obtain uniform ion bombardment.

As a more cost effective alternative, combining know-how in DC+RF technology and plasma simulations together with the successful high performance process kit on CLUSTERLINE® 200 for AlN, can now bring the combination of wafer-in-wafer thickness and stress uniformities of Al0.8Sc0.2N thin films on 8 inch wafers to an unprecedented level of control.

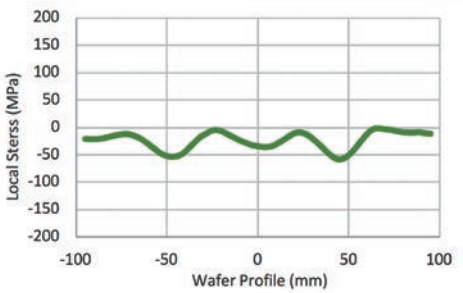


Figure 3. Within-in-wafer stress profile for an Al0.9Sc0.2N film deposited with the optimized process. The stress range is below ±50 MPa up to 5mm E.E.

Take a look at the results

A stress range of < ±50 MPa can be achieved on the whole wafer surface (5mm E.E.), while keeping the thickness non-uniformity below 0.5% (1σ). The film surface is also free from abnormal crystallites, ensuring superior dielectric properties and ease of process integration into BAW manufacturing.

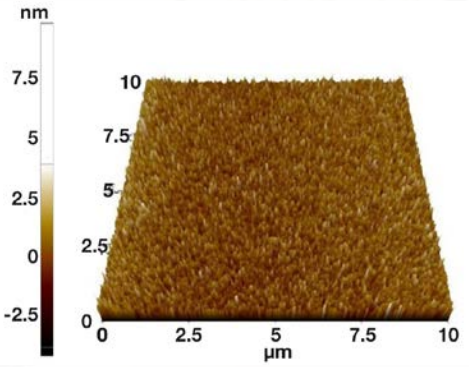


Figure 4. 10um by 10um AFM topography of an Al0.8Sc0.2N film deposited on Mo bottom electrode: the surface is free of abnormal grains.

Ready for production

This upgraded process package for the CLUSTERLINE® 200 employs 6mm x 304mm diameter targets and will be available in Q2 2020.