ARRADIANCE ***Sneak Preview***

ALE-enhanced area-selective ALD of MoS_2

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Advances in semiconductor processing are essential to meet the demands for smaller sizes and greater computing power in new electronics. Achieving smaller feature sizes and denser device placement on wafers requires more precision than current production methods can provide. Traditional semiconductor fabrication relies on subtractive manufacturing, where materials are deposited across entire wafers and then partially removed through etching. This process requires multiple lithography steps, which introduce edge placement errors. Although this method has been effective for decades, the edge placement error is a significant barrier to further downscaling of device sizes.

Area-selective Atomic Layer Deposition (ALD) offers a solution by depositing materials only on targeted surfaces, exploiting the chemical differences between them. This technique reduces the need for lithography steps, thereby saving time and reducing costs. Semiconductor manufacturers are heavily investing in area-selective ALD as a crucial process for future technology. Active areas of research include using inhibitor molecules and self-assembled monolayers to block precursor adsorption on the non-growth area, as well as alternating deposition cycles with etching to remove unwanted material.

Dr. Elton Graugnard's group at Boise State University deposited MoS_2 with the MoF_6 and H_2S process on Al_2O_3, HfO_2, TiO_2 grown in an Arradiance GEMStar™ system, SiO_2 and silicon oxynitrides. They found the most growth on Al_2O_3, which they selected as a growth surface, with the silicon oxynitride as the nongrowth surface. To further enhance the selectivity, they used a supercycle of several ALD MoS_2 deposition cycles followed by several cycles of atomic layer etching of MoS_2, using water and MoF_6. This technique removes the MoS_2 from the non-growth area, enhancing the natural selectivity of this ALD process.

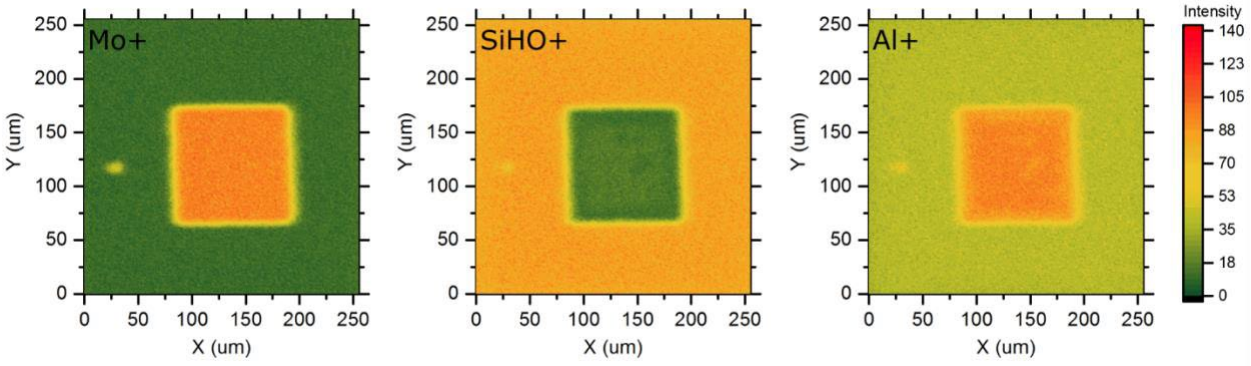

Figure 1 TOF-SIMS line scans showing the intensity of the signal from Mo+, SiHO+, and Al+ ions on a square of alumina on silicon oxinitride, showing almost no Mo on the nongrowth oxynitride.

Arradiance GEMStar™ ALD systems play a significant role in the development of area-selective ALD due to its configuration to support complex multi-material processing. For more information on GEMStar™ Technology, ALD systems or Foundry services, please contact Arradiance.

1. J. Suarez, et. al, Journal of Vacuum Science and Technology A, 2023, volume 51, 052404, doi: https://doi.org/10.1116/6.0002811