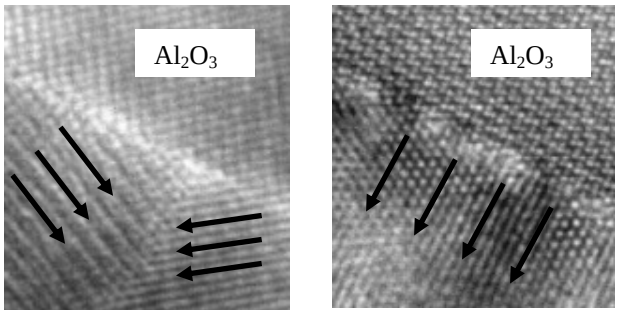
Why Coat Sapphires in Sunscreen?

New details discovered about ZnO thin films grown on Al_2O_3

Integrated deposition, diffraction, and microscopy resources housed at EMSL allowed researchers to study previously unknown structural details of oxide thin films that have potential applications to optoelectronics and spintronics. Earlier studies revealed differences in the qualities of zinc oxide (ZnO) films grown on different surfaces of crystalline Al_2O_3 – more commonly known as sapphire. EMSL users identified new and important microscopic details of the different ZnO thin film structures grown under identical conditions on Al_2O_3 surfaces with different crystalline orientations. Because thin film function depends on structure, such detailed characterization is a necessary step toward atomic-level design of thin films for targeted applications.



High-resolution TEM images of portions of ZnO thin films grown on c-cut Al_2O_3 (left) and r-cut Al_2O_3 (right). Arrows indicate the prime direction of the ZnO thin film grown on the different bonding surfaces. The r-cut substrate yielded high-quality single crystals.

For their studies, the team from the Pacific Northwest National Laboratory and University of Idaho compared thin film growth on Al_2O_3 cut along two different planes to yield two different ZnO bonding surfaces, referred to as c-cut and r-cut. These Al_2O_3 surfaces consist of the same atoms, but for each cut the arrangement of the atoms is different. Under identical conditions, these bonding surfaces were used to grow ZnO thin films with EMSL's metal organic chemical vapor deposition capability. Differences in the ZnO thin films were then characterized using high-resolution transmission electron microscopy, electron diffraction, and high-resolution TEM image simulations.

Scientific impact: Detailed knowledge of the film structure in relation to the substrate provides researchers important tools to enable the growth of films with the desired functional properties for specific applications. Such thin film studies further EMSL's goals to characterize surfaces and interfaces with unprecedented resolution as well as to design and synthesize increasingly complex materials.

Societal impact: By understanding how substrate characteristics affect thin film formation, thin film growth conditions can be defined that will yield products with desired properties tailored for specific applications.

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