NEWS | DECEMBER 17 2018

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Scilight 2018, 510005 (2018)
https://doi.org/10.1063/1.5085399

Scilight

19 December 2018

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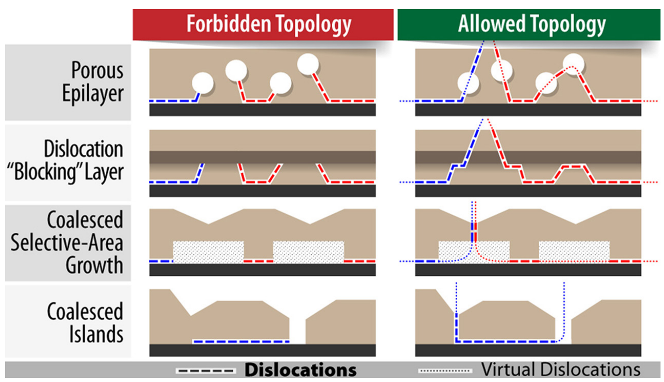
Researchers create a logical framework for visualizing dislocation topology to facilitate development of dislocation mitigation strategies for optoelectronic devices.



Creating high-quality materials for optoelectronic devices often requires growing thin films of crystalline semiconductors on dissimilar substrates, a method known as heteroepitaxy. Different techniques have been proposed to grow such films but in some cases progress is hindered by fundamental misconceptions rooted in the inherent challenge of visualizing complex dislocation networks.

Many techniques for achieving high-quality lattice-mismatched growth rely on nonplanar, complex geometries at the substrate-film interface. Typically, when a large crystalline film is being grown, it starts by nucleating as many small islands of material, which then coalesce into one continuous film. Imagine overfilling an ice cube tray with water, where the water first fills the individual pockets before merging into one larger connected pool above. While these geometries can achieve excellent material quality within each individual island of material, it doesn't guarantee that the coalescence of these islands will produce a similarly defect-free film.

Dislocation density reduction has been observed in a coalesced material, but this reduction comes from an entirely different mechanism than in islands. Island growth benefits from dislocation termination at free surfaces, whereas dislocations in the middle of a coalesced film are instead removed by pairwise dislocation-dislocation annihilation interactions.

Understanding lattice-mismatched dislocations is essential to the development of a wide range of optoelectronic devices, so McMahon et al. developed a method for using virtual dislocations to more easily visualize and understand the complexity of coalescing dislocation networks. This framework can now guide research in lattice-mismatched optoelectronic materials and devices in more promising directions.

Source: "Perspective: Fundamentals of coalescence-related dislocations, applied to selective-area growth and other epitaxial films," by William E. McMahon, Michelle Vaisman, Jeramy D. Zimmerman, Adele C. Tamboli, and Emily L. Warren, *APL Materials* (2018). The article can be accessed at https://doi.org/10.1063/1.5047945.