

Research Highlights

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Crystal film growth: nanosheets extend epitaxial growth applications

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Molecularly thin two-dimensional crystals can alleviate the lattice matching restrictions of epitaxial crystalline thin film growth, as reported by researchers in Japan.

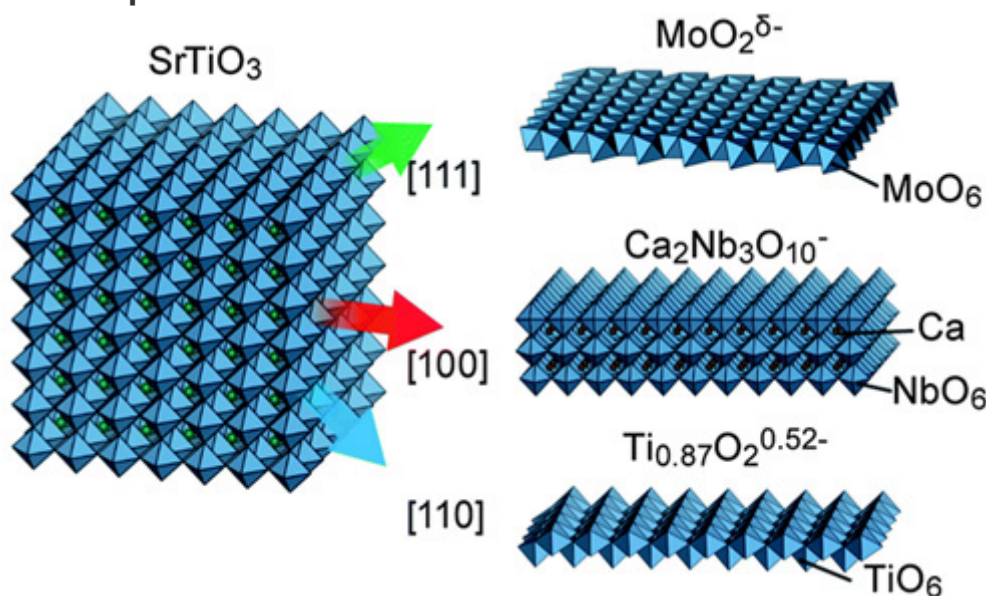


Figure : Schematic illustration of nanosheet structures for $\text{Ca}_2\text{Nb}_3\text{O}_{10}^-$, $\text{Ti}_{0.87}\text{O}_2^{0.52-}$, and $\text{MoO}_2^{\delta-}$ nanosheets and corresponding crystal planes of SrTiO_3 .

Epitaxial growth has become increasingly important for growing crystalline thin films with tailored electronic, optical and magnetic properties for technological applications. However, the approach is limited by the high structural similarities required between an underlying substrate and a growing crystal layer on top of it. Takayoshi Sasaki and colleagues at the International Center for Materials Nanoarchitectonics (MANA) and the University of Tokyo in Japan demonstrate how using two-dimensional materials they can extend the versatility of epitaxial growth techniques.

In 1984, Prof. Koma at the University of Tokyo proposed that certain layered materials such as mica or graphite can be easily cleaved to produce surfaces with no dangling bonds that would alleviate the lattice matching requirements for epitaxial growth. Interactions between adatoms on these cleaved materials would be more prominent compared with growth on single-crystal substrates since the van der Waals interactions are weak. However, the variety of suitable cleaved surfaces is limited and handling them can be difficult.

With the increasing attention on two-dimensional materials over recent years, Takayoshi Sasaki and colleagues decided to look into molecularly thin two-dimensional crystals as possible seed layers to alleviate lattice matching requirements in a manner similar to Koma's van der Waals epitaxy. They deposited nanosheets of either $\text{Ca}_2\text{Nb}_3\text{O}_{10}^-$, $\text{Ti}_{0.87}\text{O}_2^{0.52-}$, or $\text{MoO}_2^{\delta-}$ as a highly

organised monolayers onto amorphous glass. On these different surfaces, they grew different orientations of SrTiO₃, an important perovskite for various technological applications. The approach demonstrated the ability to grow different orientations of SrTiO₃ with a high level of precision.

The researchers suggest that in the future, it would be of great interest to achieve more sophisticated control of growth geometry using nanosheets with a complex structure. They add, "Such advanced design, hardly realized with present technology, will pave a new way for further development of crystal engineering."

Reference

"Versatile van der Waals epitaxy-like growth of crystal films using two-dimensional nanosheets as a seed layer: Orientation tuning of SrTiO₃ films along three important crystallographic axes of (100), (110) and (111) on glass substrate"

Tatsuo Shibata, Hikaru Takano, [Yasuo Ebina](#), Dae Sung Kim, Tadashi C. Ozawa, Kosho Akatsuka, Tsuyoshi Ohnishi, Kazunori Takada, Toshihiro Kogure, and [Takayoshi Sasaki](#)

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