Growing ultrathin 2-dimensional crystals inside atomically-flat van der Waals molds

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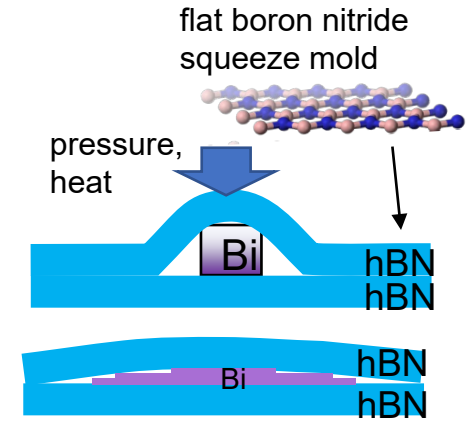
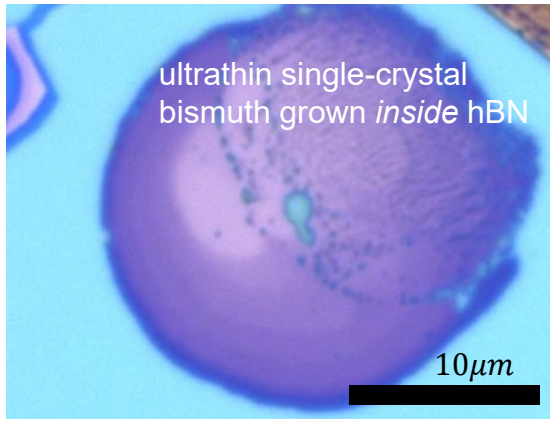
Materials exhibit dramatically different properties when confined to a 2-dimensional (2d) form. But, current techniques to produce 2d crystals are limited to certain material classes.

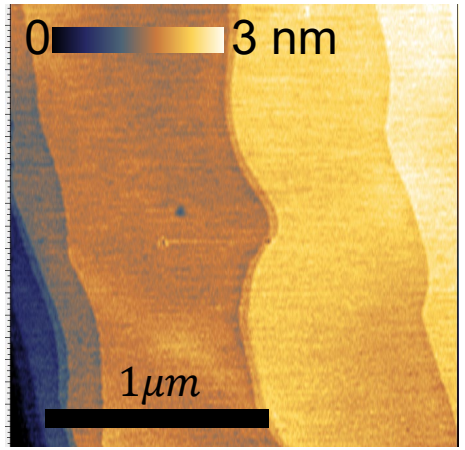
Team's guiding question: Can the materials be squeezed down to the 2-dimensional limit?
Team's goal is to Develop new method for growing 2D crystals of non-van der Waals layered materials and Produce 2D bismuth and measure its potential as a room temperature topological insulator for spintronics and quantum computing applications.

Team uses the unique approach: "2D Squeeze-mold growth", which involves the growth of crystals *inside* an atomically-flat mold made from van der Waals materials while applying pressure. Using this approach, Bismuth was grown ultra-thin (down to 4nm) and ultra-flat (100x flatter than bismuth grown by molecular beam epitaxy) single-crystal with the layered Bi 111 orientation. The material shows improved electronic properties compared to films grown by molecular beam epitaxy due to the improved flatness.

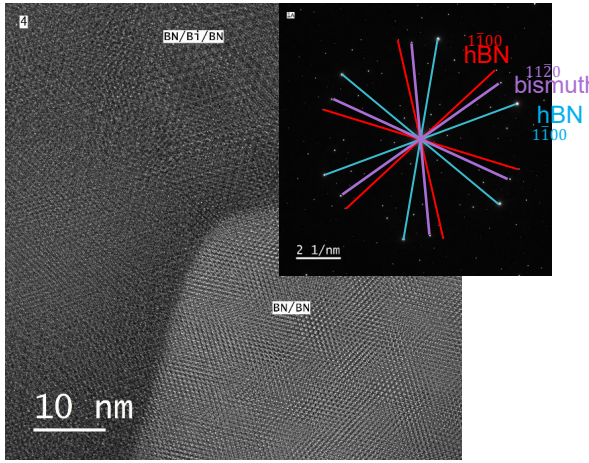
This study provides a general new method for growing ultrathin crystals that can be extended to other materials such as tin, gold, complex alloys, etc. and will enable the first quantum electronic studies of topological 2D bismuth for spintronics and quantum computing applications.







Ultra-flat bismuth surface templated by hBN mold



Single-crystal Bi 111 down to 5nm thick.

Chen L, Wu A, Campbell M, Gadre C, Wu R, Pan X, Jauregui L, **Sanchez-Yamagishi J**, (Manuscript in preparation)