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Growth and Characterization of Silicon at the 2D Limit ANDREW MANNIX, BRIAN KIRALY, Northwestern University, Dept. of Materials Science and Engineering; Argonne National Lab., MARK HERSAM, Northwestern University, Dept. of Materials Science and Engineering, Chemistry, and Medicine, NATHAN GUISINGER, Argonne National Lab. — Because bulk silicon has dominated the development of microelectronics over the past 50 years, the recent interest in two-dimensional (2D) materials (e.g., graphene, MoS_2, phosphorene, etc.) naturally raises questions regarding the growth and properties of silicon at the 2D limit. Utilizing atomic-scale, ultra-high vacuum (UHV) scanning tunneling microscopy (STM), we have investigated the 2D limits of silicon growth on Ag(111). In agreement with previous reports of sp^2-bonded silicene phases, we observe the temperature-dependent evolution of ordered 2D phases. However, we attribute these to apparent Ag-Si surface alloys. At sufficiently high silicon coverage, we observe the precipitation of crystalline, sp^3-bonded Si(111) domains. These domains are capped with a $\sqrt{3}$ honeycomb phase that is indistinguishable from the silver-induced $\sqrt{3}$ honeycomb-chained-trimer reconstruction on bulk Si(111). Further *ex-situ* characterization with Raman spectroscopy, atomic force microscopy, cross-sectional transmission electron microscopy, Raman spectroscopy, and X-ray photoelectron spectroscopy reveals that these sheets are ultrathin sheets of bulk-like, (111) oriented, sp^3 silicon. Even at the 2D limit, scanning tunneling spectroscopy shows that these silicon nanosheets exhibit semiconducting electronic characteristics.

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