

Epitaxially grown h-BN on Ir(111) A one atomic thick layer under ion irradiation

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Chemical vapor deposition of $B_3N_3H_6$ molecules on Ir(111) results in a well aligned monolayer of hexagonal boron nitride (h-BN) which forms an incommensurate (11.7 x 11.7) moiré on (10.7 x 10.7) substrate unit cells. The center of each unit cell provides a chemisorbed valley area, where h-BN is hybridized with the Ir substrate. Exposing such a monolayer of h-BN on Ir(111) at room temperature to low energy Xe^+ irradiation causes amorphization of the 2D layer, as evidenced by low energy electron diffraction. The recovery process is followed up to 1550 K using scanning tunneling microscopy (STM), low energy electron diffraction (LEED) and X-ray photoelectron spectroscopy (XPS). Surprisingly, upon annealing the h-BN layer and the moiré recover to good perfection, except of blisters formed due to aggregation of implanted noble gas species, as well as vacancy clusters and larger vacancy islands resulting from sputtering. With STM we image through the h-BN blister lid and find a superstructure corresponding in lattice parameter to what we expect for a crystalline, pressurized Xe. The blisters survive annealing to 1550 K, a temperature where pristine h-BN on Ir(111) is already decomposed. They transform to a triangular shape, driven by the energetic preference of boron terminated edges. The extraordinary stability of Xe-filled triangular, boron-terminated h-BN blisters is confirmed by dedicated DFT calculations. The vacancy clusters form an ordered array of holes in the h-BN layer (a nanomesh), precisely at the locations of the valleys, as there h-BN edges bind strongest to the substrate. Such a nanomesh membrane could be well suited for water purification applications. Finally, we report on experiments investigating the chemical reactivity of the valley region by deposition of metallic and non-metallic elemental species, in order to determine the suitability of the h-BN layer on Ir(111) as a template for aggregation of clusters, providing opportunities for nano-catalysis or nano-magnetism.