Abstract

Borophene is a fully synthetic form of two-dimensional (2D) boron, which has spurred broad interest in its unique material attributes such as in-plane anisotropy, high mechanical strength and flexibility, and phonon-mediated superconductivity. We discover covalent hydrogenation of borophene with markedly improved chemical stability in ambient conditions. We have also tamed the unruly element boron and demonstrated the first ever synthesis of double layered borophene materials, which is an extension of the phase space for boron-based nanomaterials. By engineering the dimensionality of borophene, we have achieved borophene nanoribbons with well-defined edge configurations. The confined electron wave functions in the borophene nanoribbons lead to the observation of energy level quantization and spatial nodes characteristic of quantum-well states. Our results demonstrate the ability to harness synthetic 2D borophene for a range of applications in electronic, optoelectronic, sensing, and quantum technologies.