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Patterning and Thinning of Black Phosphorus with Scanning Probe Nanolithography[1] XIAOLONG LIU, KAN-SHENG CHEN, SPENCER WELLS, ITAMAR BALLA, JIAN ZHU, JOSHUA WOOD, MARK HERSAM, Northwestern Univ — Two-dimensional (2D) black phosphorus (BP) has attracted significant interest due to its desirable electronic and optical properties. The preparation of thin BP layers primarily relies on exfoliation without precise control over flake size and thickness. We take advantage of the high chemical reactivity of BP in ambient conditions to realize patterning and layer-by-layer thinning of BP with conductive atomic force microscopy. It allows BP flakes to be locally patterned with lateral spatial resolution down to the ˜10 nm scale. The locally oxidized phosphorus getters environmental water, resulting in a liquid-phase patterning byproduct that is easily removed by water rinsing. We further demonstrate an alternating current bias method that enables direct patterning of BP on dielectric substrates for device fabrication. Using this method, BP field-effect transistors with patterned channels show significant improvement in current modulation by up to a factor of 50. The generality of this patterning method suggests that it can be extended to other 2D materials, thereby facilitating fundamental research and device prototyping (X. Liu, M. C. Hersam, *et al. Advanced Materials*, 2016, DOI: 10.1002/adma.201604121).

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