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Passivation of Exfoliated Black Phosphorus Transistors Against Ambient Degradation[1] SPENCER WELLS, JOSHUA WOOD, DEEP JARIWALA, KAN-SHENG CHEN, EUNKYUNG CHO, VINOD SANGWAN, XIAOLONG LIU, LINCOLN LAUHON, TOBIN MARKS, MARK HERSAM, Northwestern University — Unencapsulated exfoliated black phosphorus field-effect transistors are found to rapidly degrade upon exposure to ambient conditions, causing large increases in threshold voltage after only 6 h in ambient, followed by a $\sim 10^3$ decrease in FET on/off ratio and mobility after 48 h. Careful investigation into the cause of this degradation suggests that H_2O irreversibly reacts with unprotected, exfoliated BP to form oxidized phosphorus species, as observed by AFM, TEM, XPS, Fourier transform infrared spectroscopy, and electrostatic force microscopy. This interpretation is further supported by the observation that BP degradation occurs more rapidly on hydrophobic octadecyltrichlorosilane self-assembled monolayers as opposed to hydrophilic SiO_2, implicating an edge-based intercalation of O_2 saturated H_2O in BP as the cause of degradation. Atomic layer deposited AlO_x overlayers were found to suppress ambient degradation, allowing encapsulated BP FETs to maintain high on/off ratios of $\sim 10^3$ and mobilities of ~ 100 $cm^2/(Vs)$ for over one month in ambient, demonstrating the effective passivation of BP flakes against ambient degradation [1].

[1] J.D. Wood, S.A. Wells *et al., Nano Lett.* **ASAP**, DOI: 10.1021/nl5032293

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