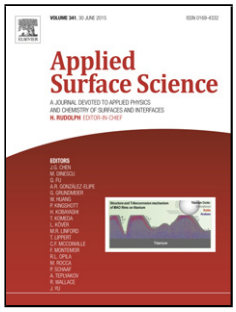

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Degradation Pattern of Black Phosphorus Multilayer Field–Effect Transistors in Ambient Conditions: Strategy for Contact Resistance Engineering in BP transistors

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► Electrical degradation mechanism at channel and contact in black phosphorus field-effect transistor is separately suggested.

► Time dependent various electrical parameters such as carrier mobility, threshold voltage, and contact resistance are presented up to 2000 min.

► Oxygen doping effects on contact and surface oxidation effects on the surface of the channel in the black phosphorus transistors are highlighted.

Abstract

Black phosphorus (BP) has been proposed as a future optoelectronic material owing to its direct bandgap with excellent electrical performances. However, oxygen (O_2) and water (H_2O) molecules in an ambient condition can create undesired bubbles on the surface of the BP, resulting in hampering its excellent intrinsic properties. Here, we report the electrical degradation pattern of a mechanically exfoliated BP field–effect transistor (FET) in terms of the channel and contact, separately. Various electrical parameters such as the threshold voltage (V_{TH}), carrier mobility (μ), contact resistance (R_{CT}) and channel resistance (R_{CH}) are estimated by the Y function method (*YFM*) with respect to time (up to 2000 min). It is found that R_{CT} reduces and then, increases with time; whereas, the behavior of R_{CH} is vice versa in ambient conditions. We attribute these effects to oxygen doping at the contact and the surface oxidation effects on the surface of the BP, respectively.