Abstract Submitted
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Nanoscopy of Black Phosphorus Degradation[1] SAMPATH GAMAGE, Georgia State University, ZHEN LI, HAN WANG, University of Souther California, VLAD YAKOVLEV, Georgia State University, STEPHEN CRONIN, University of Souther California, YOHANNES ABATE, Georgia State University — We report on the experimental quantification of geometric properties and theoretical modeling of the chemical degradation process of black phosphorus (BP) and investigate the effectiveness of passivation coatings using infrared near-field nanoscopy. We chemically identify oxidized phosphorus species locally at the onset of degradation by nanoscale spectroscopic imaging at mid-infrared frequencies. We found that these species can form underneath 5 nm thick Al2O3 coating deposited by atomic layer deposition (ALD) indicating that thin coating is insufficient to protect BP against degradation caused by ambient medium. By performing simultaneous topographic and optical time series imaging over several months, we show that a nanolayer BP exposed to ambient environment degrades at a steadily increasing rate until saturation begins, so that the degraded area and volume of degraded regions as functions of time follow the well-known S-shaped growth curve (sigmoid growth curve). Phenomenological modeling of experimental results suggests a strong influence of degraded areas on adjacent BP. Our model is advantageous since it is based on elementary probabilities that can be related to the O2 and H2O content in the ambient medium, as well as to the chemical reaction processes that result in oxidized phosphorus species.

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Yohannes Abate
Georgia State University

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