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Stability and Surface Reconstruction of Bi2Se3 on Exposure to Atmosphere

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The new class of topological materials including Bi2Se3 offer opportunities to develop next generation electron devices that utilize spin generation and detection without ferromagnetism [1]. However, the fate of the Bi2Se3 surface upon exposure to atmosphere remains unclear. In particular whilst the topology of Bi2Se3 guarantees the presence of a metallic surface, the topological properties of the metallic surface depend on the surface and its reconstruction [2]. Therefore, it is essential to understand the structure of the air-exposed Bi2Se3 surface in order to interpret the properties of any air-exposed Bi2Se3 device.

Utilizing high-resolution surface sensitive XPS we reveal that five minute air exposure causes a drastic change to the surface of in-situ cleaved Bi2Se3. An additional component within the Bi 5d core level was observed after exposure that corresponds to the formation of isolated ~0.8 nm thick Bi2 layers at the surface of Bi2Se3 [3]. This Bi2 layer is found to occur across multiple samples and is precipitated rapidly by exposure to atmosphere, while samples left for several days in UHV after in-situ cleaving show no change. This finding offers new avenues to study a 2D TI (Bi2) interfaced with a 3D TI (Bi2Se3) but also has significant consequences in understanding the electronic structure of air-exposed Bi2Se3.

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[2] Q. D. Gibson, et al., Phys. Rev. B 88, 081108(R) (2013).
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Summary

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