Centre for Doctoral Training in Condensed Matter Physics

CDT-CMP Seminar Series

2:30pm Tuesday 28th February 2017

'Novel Semiconductor Heterostructures'

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Since the discovery that graphite can be thinned down to a single layer, graphene[1], there has been intense research on other materials that too can be isolated in the few layer forms, "2d materials". Perhaps among the most interesting of these materials are the semiconducting transition metal dichalcogenides (TMDs), which have been described as candidates for next generation transistors[2]. This presentations looks at two of the more unusual TMDs ReS2 and ReSe2. The rhenium dichalcogenides are unique amongst the TMDs in that (i) they only exist in a low symmetry structure, a distorted 1T polymorph[3] (2) they exhibit in-plane anisotropic optical and electronic properties[4] and (3) they have a relatively large unit cell. Despite the vast amount of research done on these TMDs there still seems to be some fundamental questions surrounding ReS2, including the size of the unit cell [3, 5] and the direct/indirect nature of the band gap[6, 7]. This presentation will describe work that is ongoing trying to answer these questions through Angle Resolved Photoemission Spectroscopy (ARPES) and Raman spectroscopy measurements. Also presented is the first direct electronic bandstructure measurements of ReSe2 using nano-ARPES. The lattice dynamics of the rhenium dichalcogenides will be described[8] [9].

1. Novoselov, K.S., et al., Electric field effect in atomically thin carbon films. Science, 2004. 306(5696): p. 666-669. **2.** Wang, H., et al., Integrated Circuits Based on Bilayer MoS2 Transistors. Nano Letters, 2012. 12(9): p. 4674-4680. **3.** Lamfers, H.J., et al., The crystal structure of some rhenium and technetium dichalcogenides. Journal of Alloys and Compounds, 1996. 241(1-2): p. 34-39. **4.** Liu, E.F., et al., Integrated digital inverters based on two-dimensional anisotropic ReS2 field-effect transistors. Nature Communications, 2015. 6. **5.** Murray, H.H., et al., Structure of Rhenium Disulfide. Inorganic Chemistry, 1994. 33(19): p. 4418-4420. **6.** Tongay, S., et al., Monolayer behaviour in bulk ReS2 due to electronic and vibrational decoupling. Nature Communications, 2014. 5. **7.** Gutierrez-Lezama, I., et al., Electroluminescence from indirect band gap semiconductor ReS2. 2d Materials, 2016. 3(4). **8.** Hart, L., et al., Rhenium Dichalcogenides: Layered Semiconductors with Two Vertical Orientations. Nano Letters, 2016. 16(2): p. 1381-1386. **9.** Wolverson, D. and L.S. Hart, Lattice Dynamics of the Rhenium and Technetium Dichalcogenides. Nanoscale Research Letters, 2016. 11.

The seminar will take place via video link in Access Grid Room 3.29, Physics, University of Bristol and 3WN 3.8, University of Bath

If you would like to meet with the speaker before the seminar please contact cdt-cmp@bristol.ac.uk

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