SEMINARIUM RENTGENOWSKIE

Dnia 17.12.2019 r. o godz. 10.30, w sali D Instytutu Fizyki PAN, odbędzie się seminarium rtg., na którym **dr Jeremy Sloan z University of Warwick, UK,** wygłosi referat na temat:

Crystallography and Functional Evolution of Atomically Thin Confined Nanowires

Summary:

Encapsulated nanowires (so-called 'Extreme Nanowires') can be as small as a single atom in width and are the smallest one-dimensional materials. Their simplicity and robustness make them ideal platforms for the study of fundamental properties of matter, such as phase transformations and the energetics of confined crystal structure formation. Carbon nanotubes are ideal templates for forming and observing crystalline/non-crystalline transitions and molecular ordering either into chains or discrete species. These materials have tested, and continue to test, the state of the art in electron microscopy (i.e. HRTEM or STEM) investigations and their associated spectroscopies but the extremely small size also lends these materials to *ab initio* theoretical investigations whereby their stability, electronic properties and properties can all be studied. This work is leading to ground-breaking and transformative new studies including the physical realisation of Peierls distortions of 1D chains, novel phonon optics and, most recently, spectacular modification of thermal properties [1-3]. A further recent innovation is the observation and study of confined phase transformations at the smallest volume scale ever attempted (i.e. ~1 nm^3), an essential precursor to the determination of the smallest scale that we can write information by the technique of PC-RAM. Forming nanowires at such small physical scales presents unique and benchmarking challenges for high performance electron microscopy and spectroscopy as these must perform at or close to the level of single atom sensitivity. In this presentation, the interrelationships between nanoscale structural synthesis, formation and characterisation; theoretical investigations and optical characterisation of confined single to few atom thick nanowires leading to exploitable properties at the picoscale (i.e. Fig. 1) will be discussed and new methodologies for their 4D characterisation (i.e. structural evolution with time) will also be presented [4,5].

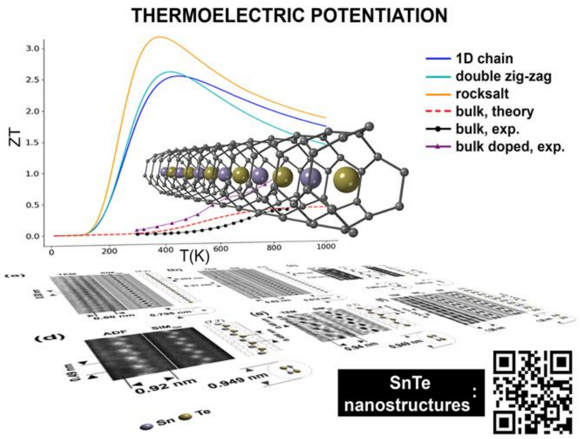

Fig. 1 Effect of Nanostructuring SnTe on the Seebeck Coefficient (ZT) *vs.* the bulk phase. Plot is ZT vs. T(K). Insets include a 1D SnTe inside a (6,6) SWCNT and (bottom) the nanostructures observed, modelled and also

References

[1] *Raman Spectroscopy of Optical Transitions and Vibrational Energies of ~1 nm HgTe Extreme Nanowires within Single Walled Carbon Nanotubes* J. H. Spencer, J. M. Nesbitt, H. Trewhitt, R. J. Kashtiban, G. R. Bell, V. G. Ivanov, E. Faulques, J. Sloan, D. C. Smith, *ACS Nano* **8**, 9044–9052 (2014).

[2] *Single-Atom scale structural selectivity in Te nanowires encapsulated inside ultra-narrow single-walled carbon nanotubes* P. V. C. Medeiros, S. R. Marks, J. M. Wynn, A. Vasylenko, Q. Ramasse, D. Quigley, J. Sloan, A. J. Morris, *ACS Nano*, 11, 6178–6185 (2017)

[3] Electronic Structure Control of sub-Nanometer 1D SnTe via Nanostructuring within Single-Walled Carbon Nanotubes A. Vasylenko, S, Marks, J. M. Wynn, P. V. C. Medeiros, Q. M. Ramasse, A. J. Morris, J. Sloan, and D. Quigley, *ACS Nano* **12**, 6023–6031 (2018).

[4] *Confined Crystals of the Smallest Phase-Change Material* C. E. Giusca, V. Stolojan, J. Sloan, F. Börrnert, H. Shiozawa, K. Sader, M. H. Rümmeli, B. Büchner, S. R. P. Silva, *Nano Lett.* **13**, 4020–4027 (2013).

[5] *In Situ Electron Beam Amorphization of Sb_2Te_3 within Single Walled Carbon Nanotubes* S. R. Marks, K. Morawiec, P. Dłużewski, S. Kret, J. Sloan, *Acta Phys. Polon. A*, **131**, 1324–1327 (2017).

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