Fall 11-10-2015

Substitution and sustainability in functional materials and devices

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Substitution and Sustainability on Functional materials and Devices

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Functional Materials and Devices (FMD) is a rapidly evolving subject which underpins many aspects of modern life such as antennas, energy storage devices, multicomponent sensors and smart materials. At a segment size of ~£3Bn p.a., the UK represents ~25% of the total EU production. However, the FMD sector in the EU and UK relies heavily on raw materials which have geopolitical, geological and environmental constraints. The response to materials scarcity and environmental restrictions depends on the industry, but companies indicate that resource efficiency, R&D, and innovations for substitution are necessary. Our vision is to utilise materials engineering, multiscale modeling, advanced manufacturing, supply chain/life cycle analysis and industrial partnerships to establish an holistic response to substitution and sustainability within the UK FMD sector. The talk will focus on:

i) Elimination of expensive RE-oxides from the fabrication of multilayer ceramics capacitors (MLCC): Currently, the lifetime of an MLCC is enhanced by the use of ~2wt% of RE-oxide (RE = Dy, Ho). Dy is the number one most endangered element according to the US government. Eradicating Dy and Ho from the fabrication MLCC is thus an urgent priority

ii) Manufacture of actuators using PbO-free piezoelectric oxides: Environmentally friendly, PbO-free piezoelectrics) have been developed over the last decade as potential replacements for Pb(Zr,Ti)O3 (PZT). Device fabrication and characterization will be studied along with an investigation of critical issues concerning direct integration into end-user applications.

iii) Replacing exotic compounds with robust oxide ceramics in thermoelectric generators: Currently, the best thermoelectric materials (Figure of Merit, ZT > 1) for waste heat harvesting are based on tellurides, antimonides and germanides. Not only are these compounds toxic and in short supply but they are also unstable at the proposed operating temperatures. Thermoelectric generators based on equally performant, more abundant and less toxic oxide materials will be developed

iv) Replacing expensive Si based PV cells with efficient inorganic/organic perovskite hybrid cells: the next generation of PV cells are envisaged to be based on methyl ammonium lead iodide (MALI) which has been reported to have >20% efficiency and is vastly cheaper the Si based technology. However, there are major concerns about its long term stability during cell lifetime. Here, we will present initial data relating to thermal stability of MALI fabricated using two different routes.