MASSIVE Newsletter

MAnufacture of Safe and Sustainable Volatile Element Functional Materials

No.6 | September 2016

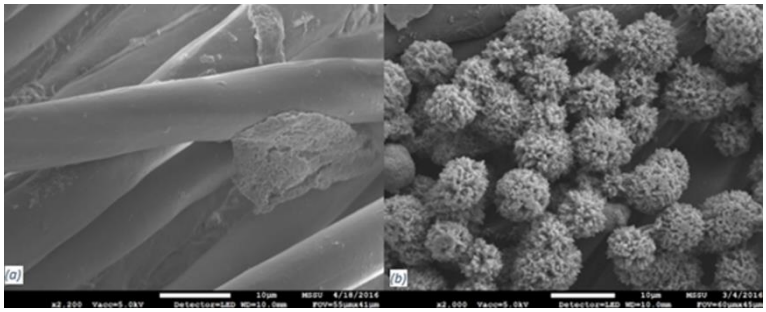
MASSIVE related projects at Surrey

Running in parallel with MASSIVE, a number of short-term projects have been undertaken throughout the year by students in the **Functional Nanomaterials** lab at the University of Surrey as part of their first degree programme. Here, we take a brief look at some of the main outcomes from these projects, which have focused on specific aspects of MASSIVE's themes of optimising powder-based deposition routes such as screen printing with potential for large scale, low cost manufacturing of electrically conductive functional ceramic films with thicknesses in the range 2-200 µm.

Manufacture of electrically conductive ceramic films In a study of conductive ceramic films produced by screen printing with aluminium doped zinc oxide inks, we have looked at the effect of doping level and post-printing heat treatment on film composition and morphology (surface roughness and porosity), key factors in enhancing the electrical properties and mechanical durability of the film. The aluminium doping route shows significant promise as a means of lowering the resistivity of films, balancing the increase resulting from film densification at elevated sintering temperatures and times.

Nanostructured functional coatings for hydrogen production Film morphology is also seen to be important in determining the catalytic activity of zinc oxide modified nanostructured Co_3O_4 coatings on copper substrates which offer promise as highly efficient cathodes for hydrogen evolution reactions (HER), an essential factor in improving the efficiency and lowering the costs involved in producing clean hydrogen fuel through the electrolysis of water. ZnO modification enhanced the rate of hydrogen production significantly compared with using pure copper cathodes by promoting a structure with increased number of charged sites, facilitating the dissociation of water.

Low temperature integration of thin ceramic films with textiles Zinc oxide grown in situ on a flexible textile substrate is a promising 'smart' material with potential for use in a variety of bio-sensing applications owing to its biological compatibility, antibacterial activity and piezoelectric properties, and the feasibility using low temperature, low cost synthesis routes scalable for industrial manufacture. The focus of this initial study of ZnO thin films and nano-rods grown on a cotton fabric by a simple water-based process was to assess the effect of varying deposition parameters - such as fabric surface treatment and processing temperature - on the morphology and activity of the coated textile.



ZnO nanoparticles grown on cotton fibres at different temperatures and reagent concentrations.

Synthesis of nano-scale Bi_2Te_3 particles for thermoelectric inks Compared with the highly wasteful 'slice and dice' technique currently used to produce bismuth telluride ingots, powder-based deposition techniques such as screen printing offer a relatively simple, efficient manufacturing route for thermoelectric device applications. Building on Surrey's capability currently being developed through the Innovate UK **ENHANCED** project in synthesising Bi_2Te_3 nanoparticles for formulating printing inks, this work aimed to establish the optimum sintering conditions for consolidating screen printed thermoelectric films.

Active materials for self-erecting lightweight deployable structures A technique was developed for fabricating soft dielectric actuators, consisting of thin silicone rubber dielectric layers combined with low stiffness conductive electrodes formed by embedding carbon black within the silicone. This process gave uniform layers with good conductivity and low stiffness and shows potential for being scaled up to produce larger devices.

Energy harvesting outreach platform And finally, in a project aimed at engaging wider interest in energy materials and their potential applications, an interactive, portable demonstrator of energy harvesting principles consisting of tessellated units using piezoelectric transducers to power LEDs when stepped on was designed, built and tested on passing members of the public. The demonstrator module certainly sparked plenty of interest and generated feedback on improvements to make the next version of the platform even more engaging!

New inkjet printing capability

Surrey's MASSIVE team has recently moved back into their lab following a summer shutdown for major building refurbishments and are now ready to start working with a new MicroFab Jetlab 4xl inkjet printer, giving the capability to print at elevated temperature with control in three axes over a 210 x 260 mm printable area using four independent fluid reservoirs. This will allow us to replicate specific manufacturing conditions and address lab-to-industry scale-up issues within MASSIVE, such as accurately co-printing n-type and p-type thermoelectric materials to intricate patterns. It will also be possible to correlate ink drop impact observations made with the printer's in situ camera with current rheological studies looking at the formulation of thermoelectric inks for inkjet and screen printing of films.

Conferences & Events

EPSRC Thermoelectric Network Meeting
18 October 2016, IET Glasgow

Collaborate with MASSIVE

The MASSIVE project team is continually looking to grow its **industrial engagement** through maintaining an active industrial advisory group, expanding its industry partner base and developing new collaborative projects. Co-funding from MASSIVE is available for collaborative projects with industry, including short-term Feasibility Studies enabling exploration of novel manufacturing concepts and evaluation of their potential to lead to longer-term strategic Industry Development Projects. Please contact us if you would like to discuss how we can work together.

Contact Us

Professor Robert Dorey
MASSIVE project lead
r.dorey@surrey.ac.uk
+44(0)1483 689608

Lynn Boniface
MASSIVE liaison
l.boniface@surrey.ac.uk
+44(0)1483 682359

www.surrey.ac.uk/massive