Applications are invited for the following a PhD studentship for the following project:

Scalable roll-to-roll nanomechanical processing of printed nanoelectronics and membranes

The position will be based with *Prof. Graham Cross* at the School of Physics, Trinity College Dublin and be part of the Engineered functional materials platform within the Advanced Materials and Bioengineering Research Centre (AMBER) centre.

Summary of project

This PhD project will investigate roll-to-roll (R2R) nanomechanical processing techniques as part of the **AMBER II Engineered Functional Materials (EFM) Research Pillar**. The 4 year project will be divided into two activities:

- **Strand 1 (EFM PROJECT 2: Printed electronic devices based on 2D materials.)**
  Mechanical compression of printed 2D material networks to realize first understanding of the role of inelastic deformation via roller delivered uniaxial strain on the conductivity of these films. The work is motivated by the PI's discovery that a combination of hydrostatic compression with confined shear stress will catalyse permanent collapse of voids in free-volume materials ranging from dense glasses to porous networks resulting, for example, in conductivity boost of PF conjugated polymer films by a factor of 102. The goal is to seek mobility in the 10 cm2/Vs regime

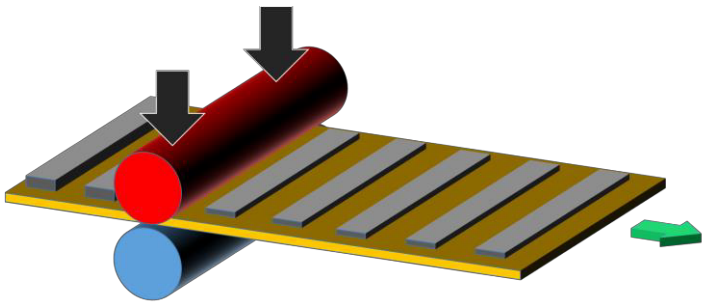

Figure 1R2R thermomechancial processing of 2D network materials. Spray printed patterns (grey) of various dimensions and orientations on polymer carrier undergo precision calendaring with varied temperature and load

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- **Strand 2 (EFM PROJECT 4: Novel membrane structures by design.)**
- Rapid, nanoscale pillar fabrication via self-assembled plasma mask formation we have established for flat-on-flat nanoimprint will be adapted to roller-imprint dies for porous membrane fabrication. Steel sheet substrate coated in diamond-like carbon (DLC) will serve as a flexible die for roller attachment. Membrane structures with 10's to 100's nm pore diameter will be formed in a formable polymer layer borne by a sacrificial web carrier at rates as high as 5 m per minute on a 10 cm diameter spool.
  Selective carrier etch will leave bonded structural skeleton supporting fully released membrane regions for testing in RB's lab.

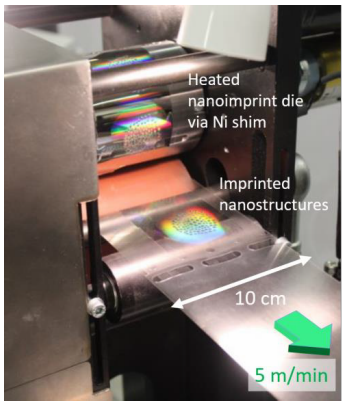

Figure 2:R2R thermomechancial processing of 2D network materials. Spray printed patterns (grey) of various dimensions and orientations on polymer carrier undergo precision calendaring with varied temperature and load

This project will establish high volume, continuous production of nanostructures and novel thermomechanical processing of advanced materials. It has long term strategic value as complementary capability to 3D printing which is limited to micrometer scale resolution.

References

1 Brazil, O., Usov, V., Pethica, J. B. & Cross, G. L. W. Large area thermal nanoimprint below the glass transition temperature via small amplitude oscillatory shear forming. *Microelectronic Engineering* **182**, 35-41, (2017).

2 Reported in *APS March Meeting Abstracts* (2016), ACS General (2017) and other meetings

3 Smirnov, W. *et al.* Anisotropic etching of diamond by molten Ni particles. *Applied Physics Letters* **97**, 073117 %@ 070003-076951 (2010).

The ideal applicants will have a 1st Class Honours Bachelor's degree in Physics, Chemistry, materials Science or a related discipline.

The researcher will work closely with other members of a multidisciplinary project team. Excellent written and oral communication skills are essential.

How to apply:

CVs with the names and addresses of three referees should be submitted to:

Prof Graham Cross, CROSSG@tcd.ie

Positions will remain opened until filled but preferred start date is *September 2 2019*. Only short-listed applications will be acknowledged.

This position is funded by the SFI-research centre AMBER.

The AMBER research centre, as a community of researchers, welcomes its responsibility to provide equal opportunities for all. We are actively seeking diversity in our research teams and particularly encourage applications from underrepresented groups.