There can be no doubt that fundamental research into a range of thin film technologies has facilitated many advances in the fields of photonics, electronics and medical devices. However it may still be argued that many of the materials that have been synthesised are not currently being used to their full potential due to the lack of suitable methods capable of making such materials on a commercially viable scale. The Advanced Materials and Surfaces group at Tyndall led by Prof Martyn Pemble is seeking to overcome this restriction, for selected materials systems and processes.

Three aspects of thin film processing are currently being explored; in the first of these like many other groups worldwide we are studying the ability to grow genuine nanoscale materials, one atomic layer or less at a time, at high volumes, using flexible substrates combined with growth processes that do not require vacuum systems to operate. In particular we are using the technique known as atomic layer deposition or ALD, at heat atmospheric pressures, to coat textile materials with a range of metal oxides using the system depicted above. The drivers here are not only the increasing deployment of smart, wearable sensor technology but also reduced oxygen and moisture permeation and even added fire retardancy.

The bench top prototype near atmospheric pressure roll-to-roll atomic layer deposition system at Tyndall.

The second area concerns our desire to demonstrate that the production of colloidal photonic crystals may (a), be automated with a high degree of reliability and reproducibility and (b), may result in useful, large-area photonic crystal layers that can enhance the performance of a range of active and passive devices. Here the films produced are periodic...
on the micrometer scale such that direct interaction with uv, visible and near IR photons is facilitated.

The Tyndall roll-to-roll system designed to prepare colloidal photonic crystal thin films on flexible substrates for potential use as anti-reflection, light trapping layers for photovoltaic devices and possible optical sensors. The system produces novel, highly ordered, 3D layers of particles whose diameter determines the wavelengths where the film becomes optically active. The system operates via the Langmuir-Blodgett mode of forced colloidal assembly.

The third area concerns our interest in the production of cheap, lightweight, reliable organic LEDs (LED) and organic photovoltaic devices (OPVs). Here, in close collaboration with the group of Prof Roberto Faria of the University of Sao Paolo, we have developed a system which is capable of depositing thin polymer films via either a doctor blade or slot die system, building up the necessary layers required to generate active device structures. Although potentially demonstrating a very cheap production route, several issues remain to be adequately addressed before this technology can be properly exploited. Perhaps the most serious of these concerns the instability of typical OLED or OPV devices induced via oxygen or moisture ingress. We are actively seeking to develop our roll-to-roll technology so as to incorporate an effective encapsulation stage designed to overcome this problem.

A roll-to-roll system at Tyndall supplied by our collaborators
A roll-to-roll system at Tyndall supplied by our collaborators
A roll-to-roll system at Tyndall supplied by our collaborators in the group led by Prof Roberto Faria at the University of Sao Paolo, Brazil. This system is equipped with a doctor blade/slot die coating head and is used for the production of organic LEDs (OLEDs) and organic photovoltaics (OPVs). The image on the left shows the entire coating system while the image on the right shows the coating head producing a stripe of polymer on a flexible PET substrate.

Roll to roll

Langmuir-Blodgett system at Tyndall in action, producing ‘stripes’ of colloidal photonic band gap materials on flexible
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Related Publications

- **Large Area 2D and 3D Colloidal Photonic Crystals Fabricated by a Roll-to-Roll Langmuir–Blodgett Method**
  *Langmuir* volume **32** issue **23** pages **5862** to **5869** (2016)
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