The Physics of Soft and Biological Matter

P.17 Controlling ink properties to achieve a 'flatter' film profile for applications in P-OLED displays

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Polymer-Organic Light Emitting Diodes (P-OLEDs) are a technology where light is emitted as a function of the electrical operation. Unlike existing technologies, such as LCDs, they do not require a backlight with filters and they can be fabricated using a flexible, ultra-thin substrate rather than an inflexible layer of glass. For these reasons they have the potential for much larger viewing angles and for use in the next generation of flexible electronics applications, such as bendable mobile telephones [1] and curved television displays [2, 3].

P-OLED printed display panels (photos by Panasonic Corp.)

During the manufacturing process of P-OLED displays a solvent containing polymer ink, is dried. Depending on the processing conditions and ink properties a variety of different film profiles can be achieved. Typically the profile has some form of undulation, which results in a non-uniform emission profile and less than optimal efficiency and display lifetime. The aim of this project is to model the dynamics of the drying process in order to determine the final deposit shape. It is hoped that the model will enable prediction of conditions that will lead to 'flatter' profiles.

The model considers an axisymmetric, pinned droplet in which a 'coffee-ring' shape will develop due to an outward Capillary flow, as discovered by Deegan and co-workers [4]. This work has relevance for a plethora of other applications in which droplets containing a dispersed material are evaporated, such as blood disease diagnostics [5], fabrication of micro/nanowires [6] and distribution of pesticides on leaves. We have developed a code to predict the final film profile as a function of a single dimensionless group –the Capillary number, as well as the initial and maximal volume fractions of polymer. Using this we can explain the experimental evidence that was obtained with the aid of white light interferometry:

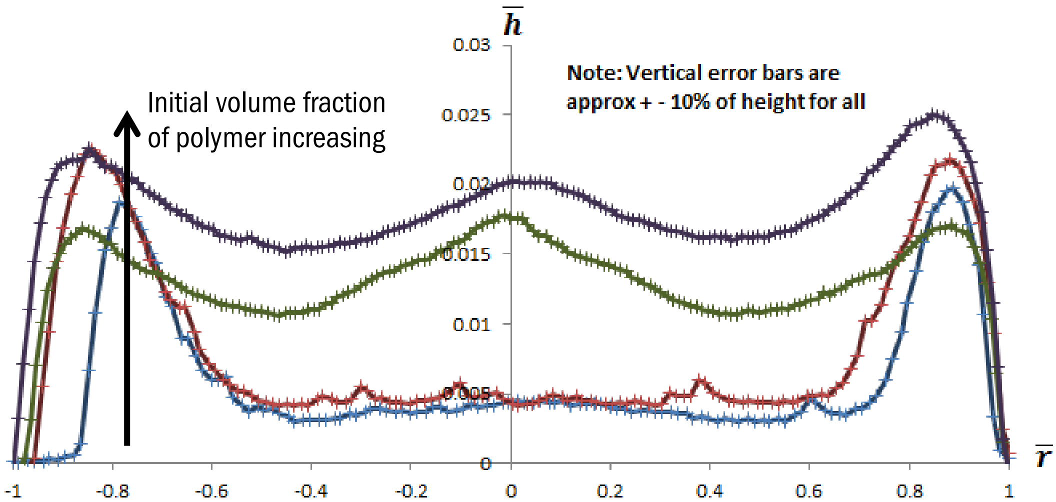

Figure: Dimensionless height against radius for droplets containing different initial polymer volume fractions

We will also present results for inks containing a mixture of solvents and discuss how the choice of ink formulation can help to achieve a flatter film profile.

[1] http://www.bbc.co.uk/news/technology-24238653
[2] http://www.bbc.co.uk/news/technology-25633199
[3] http://www.bbc.co.uk/news/technology-22335776
[4] Deegan et al., 1997, Nature, 389, pp. 827-829
[5] Brutin et al., 2011, J. Fluid. Mech., 667 pp. 85-95
[6] Naqshbandi et al., 2012, Nature Communications 3:1188