Lab rotation on AFM and SEM of perovskite thin films

Objectives

- Gain experience in the preparation of perovskite thin-films.
- Use an atomic force microscope (AFM) and a scanning electron microscope (SEM) to image a $CH_3NH_3PbI_{3-x}Cl_x$ perovskite film at various different length scales.
- Understand that processing temperatures used to prepare $CH_3NH_3PbI_{3-x}Cl_x$ perovskite thin films have a significant impact on their thin-film morphology.

Experiments

AFM Microscopy

You will obtain a one-to-one instruction on the spin-coating and annealing of perovskite thin films. Please meet up with the PhD demonstrator (Mr Mike Stringer) at 08:30 in the second year lab. Thin-film preparation will be performed in lab C21 (Hicks Building). You will be provided with a $CH_3NH_3PbI_{3-x}Cl_x$ perovskite precursor solution. Prepare a thin-film of this material by spin-coating it and then choose two different annealing temperatures or annealing times. We have found that spin-coating at 3000 rpm annealing at 90°C for t > 60 minutes results in optimal device properties in planar PEDOT:PSS/ $CH_3NH_3PbI_{3-x}Cl_x$/PCBM fabricated in Sheffield. For more details of this material, see http://www.ossila.com/products/perovskite-ink-air. If you choose to explore annealing temperatures you will need to use two different hot-plates to perform the different annealing experiments as time is limited.

You will obtain a one-to-one tutorial on the use of the AFM. Please meet with the AFM PhD student demonstrators (Mr Jonny Burns and Mr Stephen Jackson) at 10:30 in the second year lab who will take you to the AFM lab and will demonstrate the use of this technique. The demonstrator will also assist you in imaging the test samples.

Use the AFM in Tapping Mode to image the perovskite films provided. Record a selection of the images and comment on the characteristic features at the different length-scales that you observe. Use the AFM to determine the relative roughness and average thickness of the film.

SEM Microscopy

In the afternoon, you will go to the Department of Chemical and Biological Engineering (CBE) and will explore the $CH_3NH_3PbI_{3-x}Cl_x$ perovskite films fabricated using a scanning electron microscope. You will be met by Mr Richard Archer (PhD student) at 14:00 in the second year lab (Hicks Building). Richard will take you to CBE, and will show you the SEM system and explain how it works. Again you should use the SEM to record a selection of images of the perovskite films at various magnifications, and then comment on the characteristic features at the different length-scales that you observe.

From your SEM and AFM measurements, do you observed any features in the microscopy that suggest that annealing at 90°C should result in more favourable device operation?