Coating technique for e-beam sensitive polymers on non-flat surfaces and their suitability for e-beam exposure

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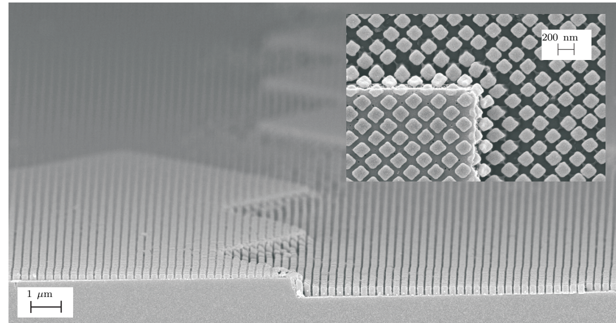
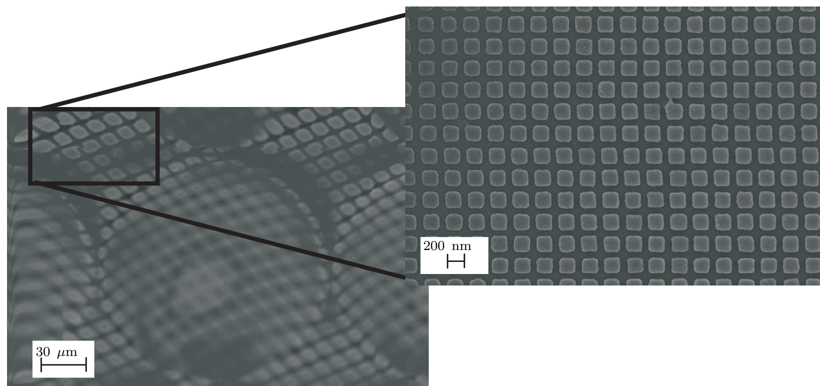
A straightforward low cost liquid phase deposition method to coat both flat and non-flat dielectric substrates with uniform electron beam sensitive polymer films is presented. Furthermore, the use of electron beam lithography to pattern the pre-form substrates coated by this method is investigated. The studied polymers are poly-methyl-methacrylate (PMMA), poly(methyl methacrylate-co-ethyl acrylate) P(MMA-co-EA) and meth methacrylate (MMA) with different molecular weights and concentrations.

This coating technique enables the coating of highly concave/convex surfaces, surfaces with some height variations, and flat surfaces. The polymer coverage over the whole surface area is shown to be uniform and the thickness of the film dependent on the used concentration of the polymer liquid or on to coating time depending on the used polymer. By using the optimized coating parameters the deposition of the polymers on various surfaces is dexterous when uniform thick or thin polymer layers are needed.

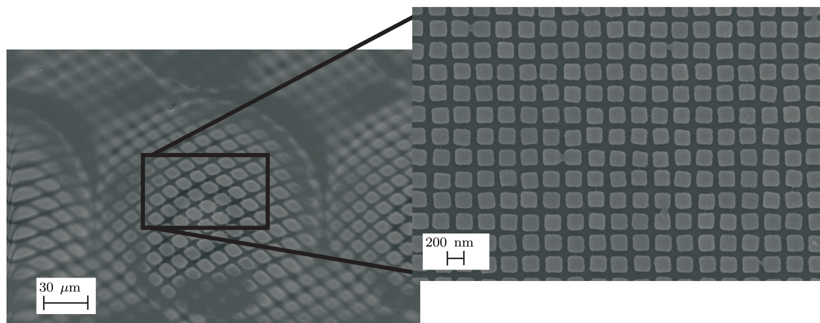
After the uniform polymer layer is deposited onto a surface by the liquid phase deposition technique, an electron beam is used to re-pattern various surfaces (flat substrates, binary elements, microlens arrays) with nano- and micronscale features. The exposure energies were determined for the different polymers having different molecular weights and concentrations. It was concluded for all polymers that the higher the concentration and molecular weight are the more dose is needed for the exposure. Also, when non-flat surfaces were patterned the effect of beam focus offset was examined and the measured change in the exposed linewidth over the ± 20 μm focus offset range was 50 nm.



(a)



(b)



(c)

Figure 1: Pre-forms patterned with nanostructure. (a) Binary pre-form with nanostructure, (b) microlens array with area between microlenses magnified and (c) microlens array with area on top of microlenses magnified.