Ultrathin iCVD films to Control Interfacial Energy for DSA Hole Shrink Applications

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Abstract*:* Integrated circuit layouts consists of patterned lines and holes, where holes define the electrical contacts between adjacent layers. Block copolymer directed self-assembly (DSA) has been shown to successfully shrink the critical dimension (CD) of these contacts beyond the resolution of conventional lithography[1, 2] DSA has also been shown to radically improve CD uniformity[3-5]. One particularly difficult step of the DSA hole shrink process involves establishing the correct interfacial energy through the templated hole to insure good assembly[6]. Initiated chemical vapor deposition (iCVD), is an ultrathin, ultraconformal all organic deposition technique that allows for precise control of interfacial energy[7, 8]. In this work we use iCVD of poly(divinyl benzene) (pDVB) at film thicknesses below five nanometers in order to blend the interfacial energy of the coated film with that of the SOC SOG template. We fully characterize the iCVD surface through means of two liquid surface energy measurements and characterize the blended interactions through Hole-Island tests. In parallel we then ran TICG simulations with the determined interaction parameters and DSA experiments, and found good agreement across the range of chemistries created. Through careful control of iCVD conditions, especially filament temperature, we achieved a strongly PS preferential sidewall with a non-preferential bottom which we then demonstrated both in simulation and in experiment allows for a successful hole shrink process across a wide range of template hole diameters (figure 1).

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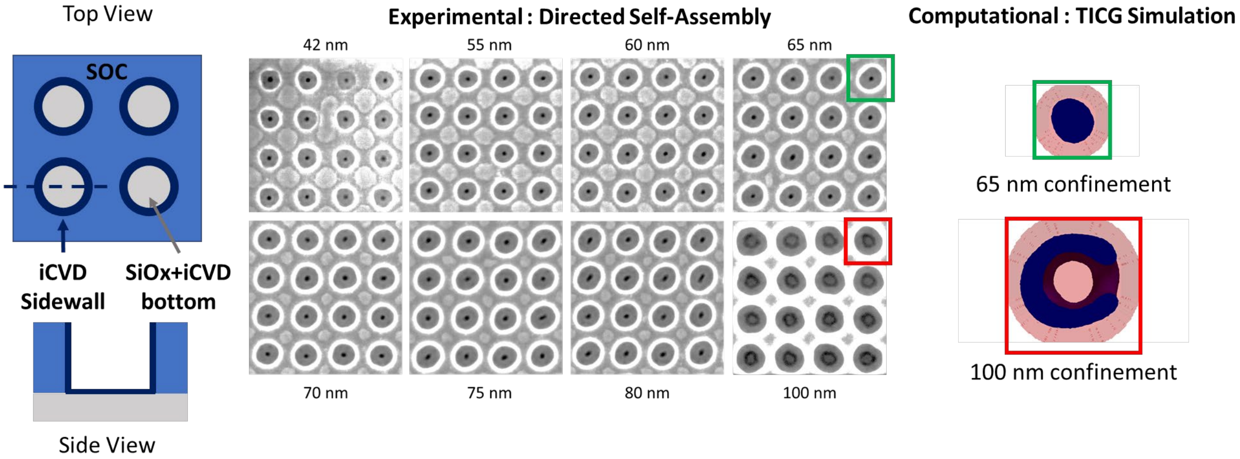

Figure 1: Templates are made in SOC/SOG using E-beam lithography, after which they are functionalized with an iCVD deposition (Left). By controlling filament temperature, the interfacial energy of the iCVD film can be precisely controlled on both the template sidewall and bottom. Both experiment (center) and simulation (right) show how a single iCVD deposition at optimized filament temperature results in a large assembly window for the hole shrink process.