566e Area Selective Atomic Layer Deposition Using Photodefinable Polymer Masks

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Atomic layer deposition (ALD) is gaining attention as a promising method for depositing high quality, conformal, ultrathin films used in the fabrication of advanced microelectronic devices. The ability to perform area selective ALD would provide a number of benefits including: (1) a reduction in the cost and number of process steps required for pattern-wise deposition of materials, (2) elimination of possible substrate and device damage induced by the traditional etching of thin films, and (3) the ability to directly pattern materials that are difficult to etch. We have previously reported the possibility of using polymer films as masking layers to develop area selective atomic layer deposition techniques (ASALDT). In this paper, we report successful application of lithographically defined polymer films to achieve the direct patterned ALD of titanium dioxide. It is observed that a number of factors must be considered in designing such photo-patternable polymeric masking materials and processes including: (1) the reactivity of the polymer with the ALD precursor species, (2) diffusion of ALD precursors through the polymer mask, and (3) remnant precursor content in the masking film during ALD cycling. These basic issues will be discussed in the context of designing and optimizing a material set and process for ASALDT using polymer masks. Results on the ALD selectivity (i.e. the analog of contrast in conventional lithographic photoresists) for a variety of different polymers will de discussed for the ALD of TiO_2. The influence of titanium precursor selection on the performance of the polymer masking layers will also be presented. These results will be discussed in more detail based on fundamental studies of the uptake, diffusion, and reactivity of ALD precursors with various polymer masking layers performed using quartz crystal microbalance techniques. Finally, directly patterned deposition of titanium dioxide structures using ALD in conjunction with several polymer masking layers and processes will be presented.