Bio-inspired Micropatterning of Ceramic Thin Films

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There has been a growing interest recently in 'bio-inspired' or 'biomimetic' approaches to prepare ceramic thin films at ambient temperatures in solutions, as they are expected to enable us to develop novel processing methods and manufacturing processes, which are low cost and environmentally friendly Conventional lithography and etching technology is facing many problems, and alternative novel technology is intensely required to overcome the present issues and to better match the future nanotechnology Bio-inspired processing is regarded as one of the promising methods to meet such a requirement

We have attempted to develop new methodology based upon bio-inspired processing to easily fabricate micropatterns of high quality Our method employs organic Self-Assembled Monolayers(SAM) formed on solid substrates They are used as templates to control site-selective deposition processes in solutions through various interactions at organic/inorganic interfaces.

The first approach is principally based on heterogeneous nucleation and growth on SAM surfaces By utilizing the chemisorption properties of the organic functional groups, it is possible to modify the nucleation process, thereby facilitating the site-selective deposition of thin films leading to high-resolution micropatterns This approach achieved very nice high-resolution micropatterns of TiO_2, ZrO_2, and $SrTiO_3$

The second approach is based on the electrostatic interactions between homogeneously nucleated particles and the substrate Surface charges, either negative or positive, would determine the deposition process in this case A micropattern of hydroxyapatite was successfully fabricated

The third approach is a little different from the above two approaches It you take a system where deposition of a solid can proceed only in the vicinity of the catalyst, site-selective deposition can take place on the patterned catalyst resulting in the formation of a solid pattern We succeeded in low-temperature fabrication of ZnO micropatterns through site-selectively catalyzed deposition in an aqueous solution Photo-patterned Self-Assembled Monolayers(SAM) with phenyl/OH-surface functional groups was used as a template Prior to the deposition of ZnO, the phenyl-group regions of the substrate were selectively catalyzed with Pd colloid particles ZnO was then electroless deposited on the Pd catalyst attached to the phenyl-surfaces giving rise to a high-resolution micropattern.