SQUARE ARRAY OF BIFEO3-COFE2O4 MUTIFERROIC NANOCOMPOSITE TEMPLATED BY LINEAR ABC TRIBLOCK TERPOLYMER

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Abstract - Microphase-separated periodic structures of block copolymers have been studied widely because they offer a simple and low cost nanopatterning methodology. Especially, thin films of block copolymers can be used as nanolithography masks for fabrication of devices. A particularly interesting structure from the point of view of microelectronic device fabrication is the square symmetry array which can be formed spontaneously by an ABC linear triblockterpolymerwith specific ranges of volume fractions and interaction parameters, where $\chi AC > \chi AB$ and χBC and $fB = 0.6 - 0.7$. Oxide nanocomposite films can show multifunctionality arising from the properties and geometries of the phases, and strain-mediated coupling between the two phases can lead tomagnetoelectricbehavior when one phase is ferroelectric and the other ferromagnetic. Among the variety of nanocomposite thin films studied, BiFeO3/CoFe2O4 (BFO/CFO) grown on (001) SrTiO3 (STO) substrate is the most thoroughly explored system owing to its well-defined self-assembled columnar nanostructure consisting of magnetic CFO pillars in a ferroelectric BFO matrix. Strong magnetoelectric coupling behavior has been demonstrated in which switching of magnetization in the CFO pillars was controlled by the electric field. This coupling provides a basis for proposed magnetic memory or logic devices. In this work, square symmetry microdomains in films ofa polyisoprene-b-polysyrene-b-polyferrocenylsilane(PI-b-PS-b-PFS) linear triblock terpolymer can be processed to form two different patterns: a square array of postsusing oxygen RIE or a square array of holes using surface reconstruction in hexane.1 The hole array can be transformed to apost array using oxygen RIE and both patterns can be produced on a substrate. Pattern transfer into silicon substrates was demonstrated via dry and wet etching processes using the hole and postarrays as etching masks. We also demonstrate the templating of asquare-symmetry BFO/CFO nanocomposite using a linear triblockterpolymerfilm as a template for topographically patterning a STO substrate.2By taking advantage of the different wetting behavior of perovskite and spinel phases, the BFO/CFO nano-columnar structure was guided by the surface topography of the Nb:STO substrate. Compared to previously reported templating methods, thisapproach achieved the smallest periodicity, 44nm, and also has the advantage of patterning large areas with low cost and a short process time. The pillar density demonstrated in this study was 5.1×1010 /cm2 and could be further increased by using a lower molecular weighttriblock terpolymer. Compared to previously reported templating methods, a patterning process based on a block copolymer can providea much smaller periodicity array over a large area with a short process time. This hierarchicalprocess in which one self-assembling system templates another could facilitate the incorporation of multiferroicnanocomposites into magnetic memory or logic devices

REFERENCES

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