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3D TEM Tomography of Bilayer Diblock Copolymer Thin Films

KEVIN GOTRIK, MIT, THOMAS LAM, NIST, ADAM HANNON, MIT, J. ALEXANDER LIDDLE, NIST, CAROLINE ROSS, MIT — Being able to control the orientation and direction of block copolymer microdomains is of interest for lithographic applications due to the ability to form sub-10 nm feature sizes. Bilayer diblock copolymer films (42 nm as-cast film thickness) of cylinder forming poly(styrene-b-dimethylsiloxane) (PS-PDMS, 45 kg/mol, Flory-Huggins interaction parameter(χ) =0.224 at room temperature) can be precisely controlled by templating arrays of PS functionalized post barriers (15 nm diameter) that are periodically spaced on the order of 30-60 nm. The resulting morphologies are 3D in nature due the ability of the posts to decouple the orientation and direction of the two different layers of cylinders. Self-consistent field theory predicts a range of possible bilayer structures that are similar in energetics and that would appear similar when viewed from the top down as is commonly done with SEM after selectively etching the PS with an oxygen plasma (50W CF_4). This destructive method of imaging therefore limits the ability to compare between different bilayer morphologies that may be forming. Here we show how 3D TEM tomography can be used as a non-destructive way to image the cylindrical microdomains to determine the block copolymer morphology before etching.

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