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Block Copolymer Self-Assembly based nanopattern creation for sub-16 nm device fabrication

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- ✤ To continue Moores' law/ statement …
- Betterment and strong demand for ICT
- Top-Down approach(Advanced Lithographic techniques)
- Bottom-Up approach(Block copolymer self-assembly)

DiBlock copolymer self-assembly



Symmetric Diblock Copolymer

A

Asymmetric Diblock Copolymer

Symmetric Diblock Copolymer



Asymmetric Diblock Copolymer



Entangled Polymer Chains



Annealing above Tg

Phase separation after annealing





Two BCP systems:

PS-b-PMMA, PS (polystyrene) - PMMA (polymethylmethacrylate)
PS-b-PDMS, PS (polystyrene)- PDMS (polydimethylsilixane)

Preparation and orientation of diblock copolymer thin film

- Spin coating for 30sec with ramp of time 5sec
- Uniform film thickness
- Low surface roughness



Parallel orientation





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Perpendicular orientation



Nanowire fabrication using PS block as a soft mask



High resolution TEM images





Fabrication of Germanium nnaowires



Figure 1. (a) Top-down SEM image of the PS template created by a selective

a

etch of the PMMA block. Inset (b) is the cross-section SEM image. (b) FIB cross-section image of PS template.

Figure 2. (a) Top-down SEM image of GeNWs obtained after PS lift-off (b) Bright-field TEM cross-section image of GeNWs obtained after PS lift-off.

Rasappa, S., D. Borah, et al. (2013). "Fabrication of Germanium Nanowire Arrays by Block Copolymer Lithography." Science of Advanced Materials 5: 1-6.



PS-b-PDMS based sub-16 nm device structures



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Top-down SEM images of PS-*b*-PDMS in 4 Inch wafer. (a) Top-down SEM image of PS-*b*-PDMS after PDMS removal and inset shows PS-*b*-PDMS before upper PDMS removal which shows no patterns. (b and c) Low resolution and high resolution of oxidised PDMS cylinders.

Future Work Graphene

PS-b-PDMS on Graphene





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Conclusions:

- BCP is the potential candidate for low feature size device fabrications.
- BCP can acts as a template to fabricate cost effective metal and metal-Oxide structures for real device applications.
- BCP is a breakthrough for Graphene nanopatterning

Thanks You so much.,.... Looking forward for Expo 2020