

Directed Self-Assembly patterning options for FinFET formation at 7nm node

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Directed self-assembly (DSA) of block copolymers (BCPs) is an alternative approach to extend optical lithography, which utilizes a topographical or chemical guiding pattern to direct the BCPs into a desired morphology at a pre-determined location while the material properties of the BCPs control the feature size and uniformity of the resulting structures. Recent studies on 193i/High Volume Manufacturing (HVM) compatibility, defectivity, and device demonstration of DSA further reinforce its role as a potential candidate for lithography extension rather than merely a lab-scale nanofabrication method.[1-3]

As pattern density increases, the conventional approach for Fin structure formation in FinFET device fabrication is limited by the combined effect of CD uniformity, LER/LWR, and placement error control of the lithography system. At 7nm technology node, the required placement accuracy for sub-30nm pitch pattern, such as fin, is approaching the limit of current manufacturing tolerance and design space constraints. In this work, three DSA options for Fin patterning are proposed and discussed, as illustrated in Fig. 1. The first approach is the Graphoepitaxy process, which enables self-aligned fin customization but slightly increases the difficulty in pattern transfer.[4] The second approach is the conventional fin-array-plus-cut method, which is known to be limited by placement error composed of overlay control, LER, and pitch-uniformity. By analyzing the LER along each processing steps, the contribution of each step can be understood and potential improvement are demonstrated. The third approach is a hybrid DSA scheme with self-aligned cut by embedded hard mask as demonstrated by Cheng et al.[5] The design concept is similar to the graphoepitaxy process, except the resist covered region defines the active fins to be preserved as opposed to the grapho case where the non-resist region defines the active fins. The self-alignment property of the grapho and hybrid process alleviates the challenge in placement error, however, new challenges arise, such as the fabrication of the guiding pattern, material optimization, and pattern transfer of the DSA structure into substrate. Preliminary learning, comparison of the DSA processes, and structural demonstration, as well as the extendibility of using DSA for devices with smaller pitches will be further discussed.

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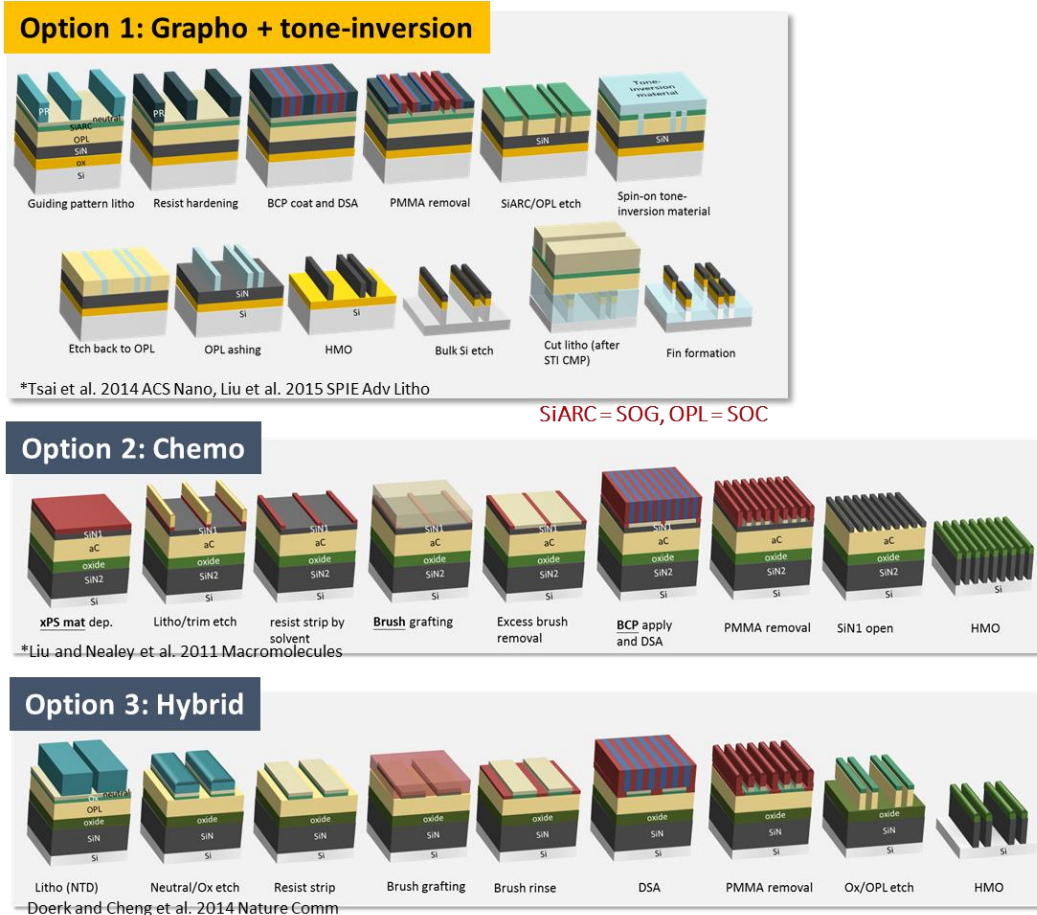


Figure 1: Process flow of DSA Fin formation.

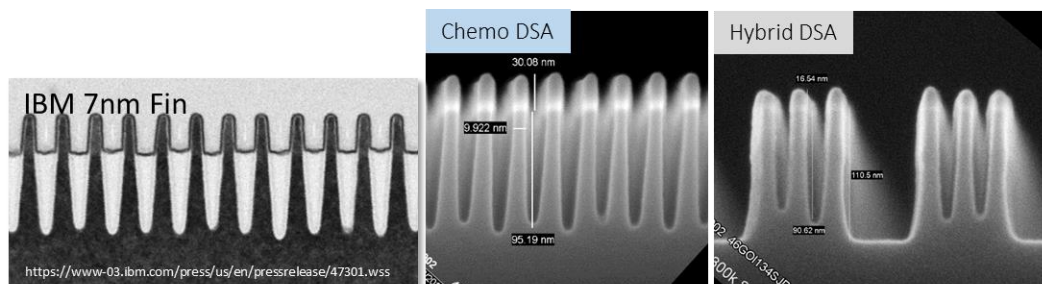


Figure 2: Examples of Fins formed by different approaches.

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