The implementation of UV and thermal nanoimprint lithography for selective area epitaxy

Didem Dede[1], Antonia Hager [1], Nicholas Morgan[1], Santhanu Panikar Ramanandan[1], Alok Rudra[1], Valerio Piazza[1], Anna Fontcuberta i Morral[1,2]

[1]*Laboratory of Semiconductor Materials, Institute of Materials, EPFL, Lausanne, Switzerland*
[2]*Laboratory of Semiconductor Materials, Institute of Physics, EPFL, Lausanne, Switzerland*

Email: didem.dede@epfl.ch

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Horizontal semiconductor nanowires (NWs) could provide a path for scalable nanowire-based devices.[1,2] The fabrication of these nanostructures relies on selective area epitaxy (SAE), which is a robust technique to grow high crystal quality structures at desired locations onto a substrate. SAE requires a precise patterning of the resist and the transfer of the pattern to the growth mask. As a patterning method, electron beam lithography (EBL) is often used in literature and offers an extraordinary accuracy suited for the purpose. However, EBL is not economically viable for large production as it has a low throughput and requires high investment and operational costs. Nanoimprint lithography (NIL) has the potential to reduce fabrication time and costs significantly while eliminating the high equipment cost.

In this work, I will first explain horizontal NW growth, and how to fabricate substrates for SAE using EBL. Then I will show how thermal and UV NIL could be used to replace EBL for substrate fabrication, elucidating the advantages and disadvantages of each lithography technique. Based on our results, the UV process is superior to thermal NIL not only in patterning quality over larger areas but especially in terms of high throughput, since the UV exposure step to polymerize the resist is faster and more controllable than cooling down a thermal NIL resist from its processing temperature. As a proof of concept, we performed epitaxial growth of Ge and GaAs NWs by MOVPE, where we observe high-quality mono-crystalline structures similar to what we obtain with EBL-processed wafers. Even though both processes can produce small uniform structures suitable for SAE, our results show that UV NIL provides the most reliable and efficient patterning of sub-100 nm mask features at the wafer scale.[3]

References

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