Chemical bath deposition of nanostructures in continuous-flow reactors

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Chemical bath deposition is a simple and cost-effective method for the preparation of nanostructures with great potential for large-scale production in industry. The deposition is typically carried out in batch reactors, where parameters such as temperature and pressure are adjusted to obtain a supersaturated solution of reactants. However, in this type of reactor, the supersaturation varies with time as the growth units are consumed, and control over the supersaturation during growth is limited. On the other hand, continuous-flow reactors are capable to maintain the supersaturation constant or to set a desired temporal supersaturation profile (Fig. 1a).

Here, we present the flow reactor design for precise control of supersaturation during the growth of ZnO nanorod arrays. A model in the COMSOL Multiphysics package was developed to calculate the spatial and temporal evolution of supersaturation, which is essential for the identification of the growth mechanisms of the nanostructures. We report for the first time the growth of periodic arrays of ZnO nanorods in flow reactors (Fig. 1b), which allowed us to correlate the morphology of the nanorods with the calculated supersaturation. Moreover, we show that compared to the ZnO nanostructures grown in the batch reactor, the nanostructures show better optical properties.

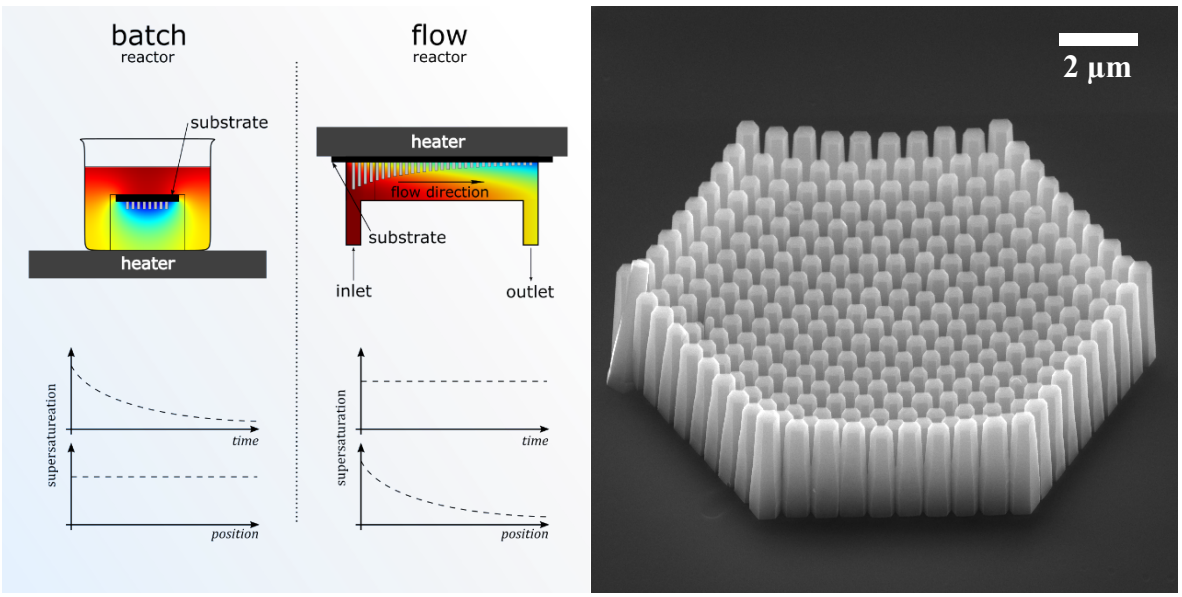

Fig 1. (a) Schematic of the batch and flow reactors and the time and spatial evolution of supersaturation within a particular type of reactor. (b) A typical periodic array of nanorods prepared in the flow reactor.