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ABSTRACT

Epitaxial semiconductor nanowires grown with vapor-liquid-solid crystallization processes are very attractive nanoscale objects for many different applications. Despite extensive studies of the growth mechanism, there is still a lack of understanding of the growth process; in particular, the stability of the vapor-liquid-solid crystallization process has not previously been studied. Here we examine the capillary stability of the vapor-liquid-solid growth of nanowires and filamentary crystals with different diameters and demonstrate that the growth is stable for small Bond numbers when the meniscus height is linearly dependent on catalyst diameter. The capillary stability of vapor-liquid-solid growth is also compared with capillary stability in the Stepanov and Czochralski crystal growth methods; it is shown that capillary stability is not possible in the Czochralski method, although it is possible in the Stepanov growth method when the ratio of crystal diameter to shaper diameter is > 1/2. These findings are important for better understanding and improved control of the growth of nanowires and filamentary crystals and indicate, for example, that large diameter filamentary crystals can be grown via a vapor-liquid-solid mechanism if the influence of gravity forces on the liquid catalytic particle shape can be reduced.

Keywords: A1. Nanostructures, A1. Growth models, B1. Nanowires, B1. Nanomaterials, B2. Semiconducting materials, B2. Semiconducting silicon, B2. Semiconducting III-V materials.