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Controlling instabilities during gold nanoribbon crystallization

BRET FLANDERS, GOBIND BASNET, KRISHNA PANTA, PREM THAPA, Kansas State University — This paper describes the electrochemical growth of branchless gold nanoribbons with ∼40 nm thicknesses, ∼300 nm widths, and greater than 100 μm lengths (giving length-to-thickness aspect ratios of well over 10^3). These structures are useful for opto-electronic studies and as nanoscale electrodes. Growing these ultra-long, branchless, crystalline structures requires controlling the Mullins-Sekerka instability, which is necessary for maintaining the template-free growth of the ribbon but has the unwanted effect of inducing side-branching. The 0.75-1.0 V voltage amplitude range is optimal for branchless ribbon growth. Reduced amplitudes induce no growth, possibly due to the reversible redox chemistry of gold at reduced amplitudes, whereas elevated amplitudes, or excess electrical noise, induce significant side-branching. An electrochemical, linear stability analysis illustrates how voltage amplitude and excess noise cause side-branching. Limitations of this linear theory will be discussed. An outcome of this study is the controlled application of electrical noise in order to produce targeted structures, such as Y-shaped nanoribbons. This research was supported by the NSF (IIA-1430493) and NIH (1R21EY026392).

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