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Instabilities of core-shell heterostructured cylinders due to diffusions and epitaxy: Spheroidization and blossom of nanowires. (English) Zbl 1162.74317

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Summary: The morphological instabilities of core-shell heterostructures consisting of an epitaxially stressed cylinder embedded in a finite shell are investigated. The contributions of the surface diffusion, interface diffusion and volume diffusion, and a combination of these processes to the mass transport along the surface of the shell and the interface between the cylinder and shell are examined, respectively. As the driving forces for the instabilities, the capillary terms and the mismatch strain energy are also taken into account. The governing evolution equations of the surface and interface are established in terms of a linear instability analysis of the longitudinal and radial variations of the surface and the interface positions. The critical conditions for the zero and maximum fluctuations of the surface and interface in the radial and longitudinal directions are given. For a core-shell cylinder of nickel, it is demonstrated that at a small size, the contribution of the surface/interface diffusion to the morphological evolution is larger than that of the volume diffusion, even at an elevated temperature. It is shown that the analysis of the instabilities of the longitudinal and radial fluctuations can be used to predict the spheroidization and blossom of core-shell nanowires.

MSC:

74A50 Structured surfaces and interfaces, coexistent phases
74H55 Stability of dynamical problems in solid mechanics

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Keywords:

linear instability; surface/interface diffusion; volume diffusion; core-shell heterostructured cylinder; nanowire

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