Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

A Three-Dimensional Phase Diagram of Growth-Induced Surface Instabilities QIMING WANG, XUANHE ZHAO, Massachusetts Institute of Technology — A variety of fascinating morphological patterns arise on surfaces of growing, developing or aging tissues, organs and microorganism colonies. These patterns can be classified into creases, wrinkles, folds, period-doubles, ridges and delaminated-buckles according to their distinctive topographical characteristics. One universal mechanism for the pattern formation has been long believed to be the mismatch strains between biological layers with different expanding or shrinking rates, which induce mechanical instabilities. However, a general model that accounts for the formation and evolution of these various surface-instability patterns still does not exist. Here, we take biological structures at their current states as thermodynamic systems, treat each instability-pattern as a thermodynamic phase, and construct a unified phase diagram that can quantitatively predict various types of growth-induced surface instabilities. We further validate the phase diagram with our experiments on surface instabilities induced by mismatch strains as well as the reported data on growth-induced instabilities in various biological systems. It is expected that the unified phase diagram will not only advance the understanding of biological morphogenesis, but also significantly facilitate the design of new materials and structures by rationally harnessing surface instabilities.

Qiming Wang
Massachusetts Institute of Technology

Date submitted: 08 Nov 2014 Electronic form version 1.4