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Evidence for a mechanical instability, via folding, of the vein network in leaves PILNAM KIM, Princeton University, MANOUK ABKARIAN, Universite Montpellier 2 / CNRS, HOWARD A. STONE, Princeton University —
The venation pattern of leaves is the archetype of a self-organized transport network whose efficiency and robustness stems from the connectivity of its hierarchical branching structure, but whose underlying principles of formation are not understood. Here we propose that the folding instability of the inner tissues of the leaf provides such a hierarchical venation pattern. Using a multi-layered polymeric system under an equibiaxial compressive stress, which mimics both growth and the layered structure of a leaf tissue, we show that a repetitive wrinkling-to-folding transition can achieve a hierarchical network of folds by continual, local reorganization of the stress field. We find that the resulting network topology, including closed loops, is the result of a spontaneous evolution of both terminal and segmental branching of the fold network and shares basic topological properties with venation patterns. This folding transition gives new insights into the role of mechanical stress as a possible feedback mechanism for cell differentiation in early veins.

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