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Finite Element Analysis of Swelling Induced Buckling of Gel Film with Holes in Square Array

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In this study, the finite element analysis of swelling induced buckling of a gel film with holes in a square array is performed using the inhomogeneous field theory in equilibrium proposed by Hong et al. (2009). Periodic units consisting of 2x2 or 10x10 unit cells are analyzed under a generalized plane strain assumption. Geometrical imperfections are introduced by considering randomly oriented elliptic holes, and the degree of pattern formulation is quantified by using a measure of deviation from roundness. Results of 2x2 unit cells show that three characteristic buckling patterns arise depending on randomness, although the most dominant one is the diamond plate pattern, which was observed in experiments. In contrast, results of 10x10 unit cells show that all random cases predict the diamond plate pattern. It is shown that this homogeneous pattern transformation is a consequence of propagation of a locally induced diamond plate structure.

Keywords: Swelling, Gels, Buckling, FEA, Pattern transformation, Imperfections