

Material Instabilities of Fiber-Reinforced Nonlinearly Elastic Solids

Jose Merodio⁽¹⁾, Ray W. Ogden⁽²⁾

(1) *Department of Structural and Mechanical Engineering, University of Cantabria, Santander, Spain*

(2) *Department of Mathematics, University of Glasgow, Glasgow, UK*

Material instabilities for fiber-reinforced nonlinearly elastic solids are examined under plane deformation. In particular, the materials under consideration are isotropic nonlinear elastic models augmented with a function that accounts for the existence of a unidirectional reinforcing. This function gives the anisotropic character to the material and is called a reinforcing model. The onset for failure is given by the loss of ellipticity of the governing differential equations. Previous work has dealt with the analysis of specific reinforcing models. It was established that the loss of ellipticity for some augmented isotropic materials requires contraction in the reinforcing direction. The loss of ellipticity was related to fiber kinking. Here we generalize these results and establish sufficient conditions that guarantee the ellipticity of the governing equations of equilibrium for more general reinforcing models. The two cases of compressible and incompressible materials are considered. The incipient loss of ellipticity is interpreted in terms of fiber kinking, fiber debonding, fiber splitting and matrix failure in fiber-reinforced composite materials.

[View the extended summary](#)