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MECHANICAL BEHAVIOR OF RANDOM FIBER NETWORKS WITH INTER-FIBER ADHESION

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Many soft materials have a random fiber network as their main structural component. Filaments may be molecular, as in rubber and gels, or athermal, as in connective tissue and various consumer products. In many of these systems, the fibers interact adhesively and are thin enough for adhesion to play effectively against the bending resistance and have an important role in mechanics. In this work, we consider both cross-linked and non-cross-linked networks, and study the relative contribution of bending/axial deformation modes and of adhesion between fibers to (a) the organization of the network in the unloaded state, as well as to (b) the mechanical behavior of the self-organized adhesive networks. We establish links between network parameters and the structure and mechanical behavior of such adhesion-stabilized fibrous structures. These provide guidelines for their design and a conceptual framework for the interpretation of experimental observations. This work finds applications in the mechanics of carbon nanotube sheets and yarns, various assemblies of protein fibers such as silk, and the mechanics of electrospun polymeric networks.