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Soft composite materials (such as tissues) are characterized by large deformations and non-linear mechanical behavior. In nature, simple repeated building blocks (e.g. collagen, proteoglycans and elastin) are used to create a variety of soft tissue structures and functions. These blocks differ in their mechanical properties; however, they share similar regimes of strain stiffening, where the initial part of the stress-strain curve is matrix-dominated followed by a fiber-dominated behavior and stiffening [1]. In tendon, for example, under an applied load a characteristic stress- strain behavior appears, composed of three main regions: toe, heel and linear regions. In the toe region, a small stress only is needed to create a large deformation. In this region, the microscopic crimp of the fibrils is straightened and the mechanical behavior is governed by the proteoglycan matrix. The matrix also enables a gliding mechanism in the linear region, whereas the viscoelasticity of the tendon is due to its hydrated nature [2-5].

Several structural mechanisms such as micro-crimping of the fibers [6-8] and sacrificial cross-linking that allow the fibril gliding [2, 3], generates the unique mechanical behavior of soft composites. These mechanisms result in a total strain of the tendon that is larger than the fibril strain and govern the transition between matrix and fiber modes.

In the present work, we have used synthetic hydrophilic fibers embedded in an alginate hydrogel matrix (that is mechanically similar to the proteoglycan matrix) to create new soft composite materials inspired by native tissue structures with straight and crimped fibers. The fibers had different degrees of crimping to tailor the nonlinear stress-strain curve and to probe the influence of the crimping on the load transfer between the matrix and fibers.

Mimicking these mechanisms may lead to better understanding of soft-tissues structure-function behavior, possibly leading to novel soft composites with superior mechanical properties.

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