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Dynamic elastocapillarity of hairy tubes JONGHYUN HA, KAIYING JIANG, SAMEH TAWFICK, University of Illinois at Urbana-Champaign — Elastocapillarity, which is the capillary-driven deformation of slender materials, can be mundanely observed in our daily lives, such as painting, washing the hair, wet grass or leaves. Here, we introduce a novel elastocapillary phenomenon in hairs assembled into ring-shaped cross sections thus forming hairy-tubes composed of an empty hole surrounded by a hairy wall. The heterogeneous hairy tubes have two distinct spacing length scales: the narrow spacing among the individual hairs and the large inner diameter of the tube which is a few millimeters. The hairy tubes are immersed in a liquid bath, and once they pierce the liquid interface, the fibers self-assemble due to the capillary action. In particular, we observe that the drainage dynamics between the fibers play an important role in the deformation trend, which has two distinct modes. The fibers locally coalesce in the low drainage rate forming tubes having smaller inner and outer diameters than the dry counterparts with denser fiber packing within the walls, while they completely collapse into round bundles and eliminate the internal diameter at the high drainage rate. Based on the physics of elastocapillarity, we theoretically and experimentally explain the shape shifting induced by surface tension, depending on the structure size and the drainage speed. This study provides the model system of capillary induced self-assembly of heterogeneous hairy structures, which have far more applications, such as micro/nanoscale manufacturing and soft actuators.

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