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Elasto-capillary windlass: from spider web to synthetic actuators<sup>1</sup> HERVÉ ELETTRO, ARNAUD ANTKOWIAK, SÉBASTIEN NEUKIRCH, Institut D'Alembert, FRITZ VOLLRATH, Oxford Silk Group, INSTITUT D'ALEMBERT TEAM, OXFORD SILK GROUP TEAM — Spiders' threads display a wide range of materials properties. The glue-covered araneid capture silk is unique among all silks because it is self tensing and remains taut even if compressed, allowing both thread and web to be in a constant state of tension. Here we demonstrate how this effect is achieved by unraveling the physics allowing the nanolitre glue droplets straddling the silk thread to induce buckling, coiling and spooling of the core filaments. Our model examines this windlass activation as a structural phase transition, which shows that fibre spooling results from the interplay between elasticity and capillarity. Fibre size is the key as such a capillary windlass requires micrometer-sized fibres in order to function. Our synthetic capillary windlasses point towards design principles for new bioinspired synthetic actuators.

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