Movie Submission:

**Creation of sacrificial bonds by a viscous flow instability**

In many natural materials such as spider silk, toughness is increased by contacts between chains - for the most part, they are hydrogen bonds - which have to be broken to allow chains extension, absorbing energy and releasing a hidden length upon stretching.

The idea is to recreate sacrificial bonds by using a fluid instability phenomenon: the « liquid rope coiling » effect. A viscous liquid thread falling on a substrate buckles repetitively under compressive stress resulting in twirls and loops. By moving the substrate at constant speed, the instability creates different patterns of meanders, loops or stitches depending of the velocity ratio between the falling thread and the substrate.

When a thread of viscous polymer solution (polylactid acid dissolved in dichloromethane) loops on itself, there is a penetration at the contact, creating a node. We obtain these results at different scales, from 200µm in fibre diameter down to 30µm. During tensile tests, these nodes will absorb some energy to be broken and then release the hidden length, increasing the specific toughness of the fiber.

To improve our results, we need to optimize different processing and instability parameters such as height and speed of the thread fall which change the solvent evaporation time and thus the strength of the contact. The ratio between thread and substrate speed will determine the pattern and thus the loop frequency and length.