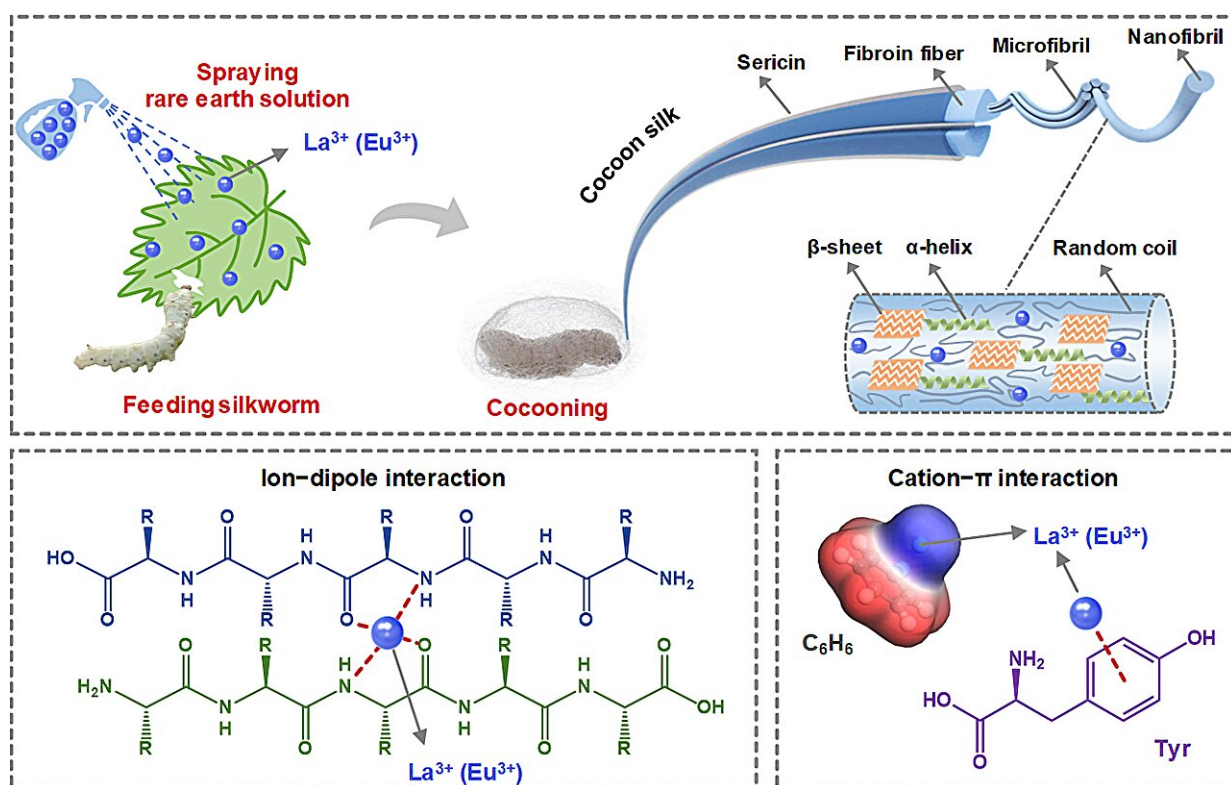


# Producing stronger, tougher silk by feeding silkworms with rare earth ion-modified diets

November 2 2023



On the above, the rare earth solution was sprayed on mulberry, which was fed to silkworm to spun reinforced silk fibers. On the below, it illustrates the ion-dipole and cation- $\pi$  interaction between rare earth ions and silk. Credit: Science China Press

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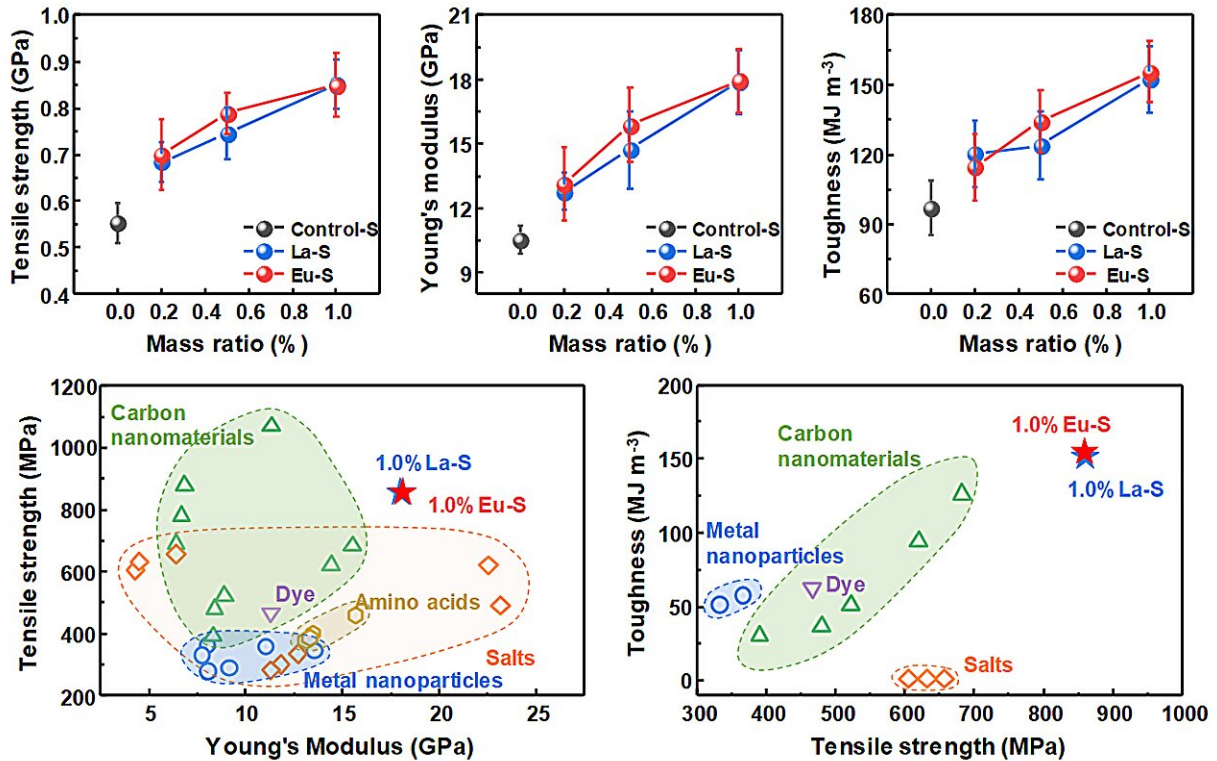
Tsinghua University) devised a scheme utilizing silkworms to produce strong, tough silk through feeding them with rare earth ion-modified diets. The rare earth ions can be incorporated into silk fibroin through feeding. And the incorporated ions are capable of forming ion-dipole and cation- $\pi$  interactions with silk fibroin. These interactions are promising to tune the structures of silk to enhance its mechanical performance.

Spectra analysis confirmed the successful incorporation of [rare earth ions](#) into [silk fibers](#), and their chemical interactions. Morphological and [structural analysis](#) demonstrated that rare earth ions reduced the diameter of silkworm silk fibers, while increasing the amorphous component content and crystalline orientation.

These chemical interactions and structural evolutions contributed to the mechanical improvement of silk fibers. The average values for [tensile strength](#), Young's modulus, and toughness reached  $0.85 \pm 0.07$  GPa,  $18.0 \pm 1.5$  GPa, and  $156 \pm 13$  MJ m<sup>-3</sup>, respectively, and maximum values reached  $0.97 \pm 0.04$  GPa,  $19.0 \pm 1.5$  GPa, and  $188 \pm 19$  MJ m<sup>-3</sup>. The comprehensive mechanical performance of this silk is comparable to spider dragline silk, and superior to that of silk modified by other functional materials.

This work provides a simple, efficient, and scalable strategy to prepare super strong and tough silkworm silk fibers. And the as-obtained silk fiber are potential candidates for medical treatment, aerospace, and sports applications.

The work is [published](#) in the journal *Science Bulletin*.



On the above, the strength, modulus, and toughness increased with the mass ratio of rare earth ions. On the below, the comprehensive mechanical performance of rare earth ion-modified silk is superior to that of silk modified by other functional materials. Credit: Science China Press

**More information:** Haojie Lu et al, Highly strong and tough silk by feeding silkworms with rare earth ion-modified diets, *Science Bulletin* (2023). [DOI: 10.1016/j.scib.2023.09.032](https://doi.org/10.1016/j.scib.2023.09.032)

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