Environmentally-Friendly, Color-Infused, Structurally-Strengthened Silk Fibers from Feed-Induced Bombyx mori

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Textiles have become the second most polluting industry in the environment, after petroleum. As a $772 billion field, businesses will need to find green, alternative solutions, due to the 2.5 billion tons of wastewater and 330,000 tons of potentially hazardous dyes that are used every year. To seek a sustainable, environmentally-friendly solution, a two-pronged approach was taken feeding directly silkworms: 1) dyes (Rhodamine-B Red and Rit Blue) to create colored silks, thereby reducing wastewater/energy usage, and 2) graphene/TiO2 to increase the silk strength for decreased degradability. The silk fibers were found to change color and be brighter on the color scale when the silkworms were fed higher concentration of dye. However, with this, the mortality rate rose by 70% with decreasing cocoon weight. Bleach wash experiments reveal the dye was internally embedded rather than externally coated for the feed-induced silk fibers. The tensile strength of graphene-silk was found to be 25.5% stronger than control. TiO2-silk performed even better (tensile strength 41.3% above control). Surprisingly, the mortality rate using TiO2 dropped at higher concentrations with TiO2 acting as an appetite enhancer increasing cocoon weight by 15.5%. As expected, after being exposed to UV light, the tensile strength for the control-silk decreased by 64%. However, TiO2-strengthened silk only decreased by 44.5%, due to its UV-protective properties. In summary, an environmentally-friendly, sustainable method to produce a new class of functional silk and a better understanding of the effect of changing feeds to silkworms on the properties of the silk fibers have been developed.

Awards Won:
Third Award of $1,000
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category
Patent and Trademark Office Society: First Award of $1,000, and an American flag and a framed copy of the first patent granted in the USA