DYNAMIC SURFACE PROPERTIES OF SILK FIBROIN FIBRILS

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Due to the formation of stable and durable interfacial films silk fibroin can be considered as an alternative to many traditional emulsifiers and surface modification agents in various branches of industry, from pharmacy to cosmetic industry [1]. Propensity of this protein to form different types of aggregates may expand the diversity of 2D fibroin-based materials. The influence of self-assembled structures of native silk fibroin, amyloid-like fibrils obtained by thermal treatment of native protein solution and their composites on dynamic surface properties was studied in this work. The difference in the behavior of silk fibroin in different forms at the air-water interface was determined using a combination of dilatation surface rheology, ellipsometry, and atomic force microscopy.

The high dynamic surface elasticity of native silk fibroin solutions (>220 mN/m) is due to the formation of a thick, dense, interconnected network at the interface. The properties of adsorbed and spread layers of silk fibroin fibrils differ significantly from those of the native protein and turns out to be similar to the amyloid fibrils of globular proteins. For fibril dispersions purified from unreacted molecules, the dynamic surface elasticity can reach only 140 mN/m due to the presence of a thin layer (7-15 nm) of intertwined aggregates on the surface, which do not form a continuous network.

In mixed systems, silk fibroin fibrils prevent the formation of supramolecular structures in the surface layer. Neither the adsorption of unreacted protein molecules in the unpurified fibril dispersion nor the addition of fibroin to a preformed fibril layer results in the formation of films with mechanical properties similar to native fibroin. Thus, the fibroin fibrils act as structural modifiers that suppress the interfacial self-organization of fibroin molecules, leading to thinner, less resilient but stable surface layers. Controlling the properties of the surface layer by combining different forms of fibroin at the interface may allow the creation of functional materials with desired properties.

1. Qiao, X.; Miller, R.; Schneck, E. Biocompatible Emulsions Stabilized by Natural Silk Fibroin. Colloids and Interfaces 2026, 10, 1–15, https://doi.org/10.3390/colloids10010013

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