Killer silk: Making silk fibers that kill anthrax and other microbes in minutes

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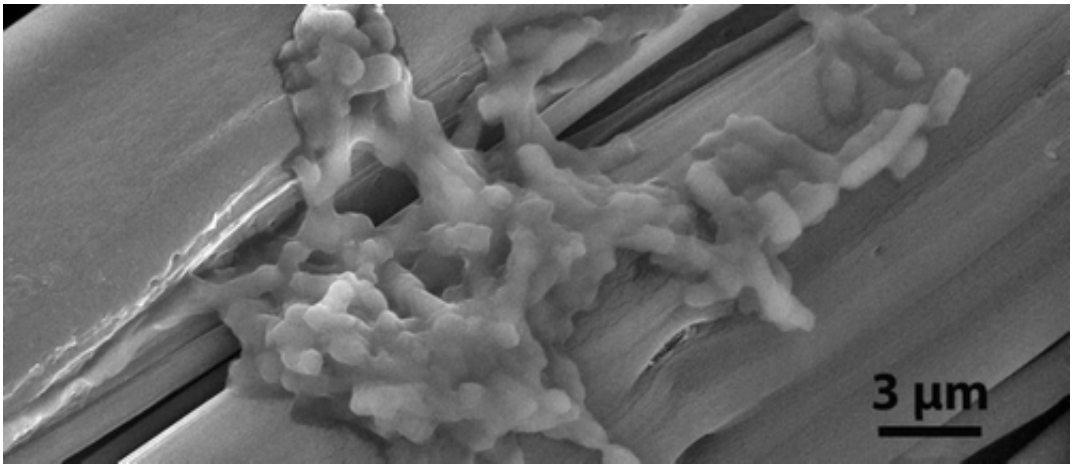

A simple, inexpensive dip-and-dry treatment can convert ordinary silk into a fabric that kills disease-causing bacteria — even the armor-coated spores of microbes like anthrax — in minutes, scientists are reporting in the journal ACS *Applied Materials & Interfaces*. They describe a range of potential uses for this new killer silk, including make-shift curtains and other protective coatings that protect homes and other buildings in the event of a terrorist attack with anthrax.

Rajesh R. Naik and colleagues explain that in adverse conditions, bacteria of the *Bacillus* species, which includes anthrax, become dormant spores, enclosing themselves in a tough coating. These spores can survive

heat, radiation, antibiotics and harsh environmental conditions, and some have sprung back to life after 250 million years. Certain chemicals — most popular among which are oxidizing agents, including some chlorine compounds — can destroy bacterial spores, and they have been applied to fabrics like cotton, polyester, nylon and Kevlar. These treated fabrics are effective against many bacteria, but less so against spores. The researchers tried a similar coating on silk to see if it could perform better against these hardy microbes.

They developed a chlorinated form of silk, which involves soaking silk in a solution that includes a substance similar to household bleach and letting it dry. Silk treated for just an hour killed essentially all of the *E. coli* bacteria tested on it within 10 minutes and did similarly well against spores of a close anthrax relative used as a stand-in. "Given the potent bactericidal and sporicidal activity of the chlorinated silk fabrics prepared in this study, silk-Cl materials may find use in a variety of applications," the authors say. Other applications, they add, include purifying water in humanitarian relief efforts and in filters or to mitigate the effects of toxic substances.

More information: Sporicidal/Bactericidal Textiles via the Chlorination of Silk, *ACS Appl. Mater. Interfaces*, Article ASAP, DOI: 10.1021/am2018496

Abstract

Bacterial spores, such as those of the Bacillus genus, are extremely resilient, being able to germinate into metabolically active cells after withstanding harsh environmental conditions or aggressive chemical treatments. The toughness of the bacterial spore in combination with the use of spores, such as those of Bacillus anthracis, as a biological warfare agent necessitates the development of new antimicrobial textiles. In this work, a route to the production of fabrics that kill bacterial spores and cells within minutes of exposure is described. Utilizing this facile

process, unmodified silk cloth is reacted with a diluted bleach solution, rinsed with water, and dried. The chlorination of silk was explored under basic (pH 11) and slightly acidic (pH 5) conditions. Chloramine-silk textiles prepared in acidified bleach solutions were found to have superior breaking strength and higher oxidative Cl contents than those prepared under caustic conditions. Silk cloth chlorinated for ≥1 h at pH 5 was determined to induce >99.99996% reduction in the colony forming units of Escherichia coli, as well as Bacillus thuringiensis Al Hakam (B. anthracis simulant) spores and cells within 10 min of contact. The processing conditions presented for silk fabric in this study are highly expeditionary, allowing for the on-site production of protein-based antimicrobial materials from a variety of agriculturally produced feed-stocks.

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