Sulfur content in some high-performance fabrics weakens them when exposed to moisture

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PhD student Saiful Hoque led new research that could point the way to developing stronger, safer protective wear for firefighters and other workers. Credit: University of Alberta

Researchers have solved the mystery of why a high-performance fabric commonly used in firefighting and other protective garments weakens prematurely when it's exposed to moisture.

The breakthrough helps solve a big safety challenge, says Saiful Hoque, a researcher in the Faculty of Agricultural, Life & Environmental Sciences.

"As the garment weakens over time, there's no way to know whether the wearer is still protected or not," says Hoque, a Ph.D. student in Textile and Apparel Science.

"Now we know the root cause, and this gives information to the manufacturers to find a solution to this problem."

The recent study investigated the accelerated hydrothermal aging of various fabrics typically used as outer shells in clothing for firefighters, oil and gas workers and electricians.

The fabrics were immersed in water at temperatures ranging from 60 to 95 C for up to 1,200 hours. After exposure, some of them lost significant tensile strength—the stress a fabric can withstand without splitting or breaking—without showing any visible signs of degradation.

The cause was found to be the high sulfur content in some of the fibers, leading to an accelerated loss in fabric strength when exposed to moisture. That degradation weakens the safety of protective garments when exposed to sweat, water, rain, snow or laundering.

Besides fiber damage, the water-repellent finish in some of the fabrics also showed degradation, which adds to safety concerns, Hoque notes.

"When a fabric starts absorbing water it transfers more heat, which can

result in burns. And water also makes what is already a heavy safety garment even heavier."

The findings shed new light on what earlier U of A research discovered about the sensitivity of some high-performance fabrics to water, says ALES professor Patricia Dolez. She led earlier research that showed laundering contributes to a loss in performance in some fire-protective fabrics.

Next steps are to share the latest findings with textile manufacturers, says Dolez, who was a co-author on Hoque's study along with Professor Hyun-Joong Chung and Ankit Saha of the U of A's Faculty of Engineering.

"We're hoping to work with the industry to come up with solutions."

The discovery will also strengthen ongoing research led by Dolez to develop end-of-life sensors that detect damage in firefighters' garments.

"We now have the data we needed on the degradation of fire-protective fabrics (due to long-term exposure to water) to select the right material to use."

The study was published in the *Journal of Applied Polymer Science*.

More information: Md. Saiful Hoque et al, Hydrothermal aging of fire-protective fabrics, *Journal of Applied Polymer Science* (2022). DOI: 10.1002/app.52666

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