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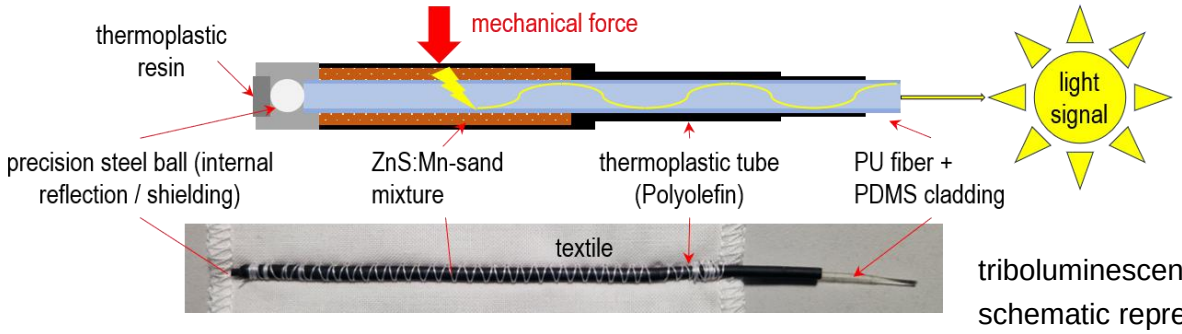
Triboluminescent textile monitors for quantification of mechanical action (01IF22930N)

Intensive mechanical action results in high soil removal but also cause significant textile damage. Since mechanical action depends on drum geometry, it cannot be quantitatively assessed solely based on set process parameters (e.g., g-factor, oscillation angle, reversal). This complicates the adjustment of washing processes and results in the situation where, even with identical process parameters, the resulting mechanical action depends on the specific machine used. This is also a reason why the testing of textiles according to ISO 15797 does not allow conclusions to be drawn regarding the service life of workwear during processing by textile service providers.

Against this background, the wfk – Cleaning Technology Institute e.V. conducted a research project with the aim of capturing and quantitatively evaluating the mechanical forces resulting from drum motion and geometry in the washing process. For this purpose, a textile mechanics monitor based on triboluminescent fibers was developed. These fibers consist essentially of polymer optical fibers coated with triboluminescent particles of manganese-doped zinc sulfide (ZnS:Mn). Triboluminescence is the emission of light from a solid under the influence of mechanical forces. Even under low mechanical loads, these particles emit a strong orange-yellow triboluminescence. The triboluminescent fibers were integrated into textile carriers. When mechanical forces act on the particles, triboluminescence signals are generated, coupled into the optical fibers, and detected at the fiber end face. In studies on wash resistance, polymer optical fibers (POF) made of polyurethane (PU) proved to be more suitable for the development of triboluminescent fibers than fibers made of polymethyl methacrylate (PMMA) due to their mechanical properties (high elasticity and flexibility, relatively small bending radii, no damage when subjected to strong bending and compression). Only at excessively high washing temperatures did a reversible clouding of the PU fiber occur, which interfered with the transmission of triboluminescence signals. To produce triboluminescent fibers, ZnS:Mn particles were combined with sand grains as micro-exciters and fixed onto the surface of the PU-based polymer optical fiber (core) by shrinking a thermoplastic tube around it. These fibers can be connected to light sensors using standard connectors, and the triboluminescence signals can be recorded under mechanical loading. By means of the developed calibration algorithms, it is possible to establish a functional correlation between the intensity of the triboluminescence signal and the magnitude of the mechanical force, thereby enabling the quantification of mechanical action.

The research report is available on request from the wfk - Cleaning Technology Institute



triboluminescent fiber: schematic representation and photo (section)

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