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**Failure modes of microstructured fibers with sacrificial bonds made by instability-assisted 3D printing** SHIBO ZOU, DANIEL THERRIAULT, FREDERICK GOSSELIN, Ecole Polytechnique de Montreal — A simple modification by increasing the deposition height on a commercially available 3D printer makes it a mechanical sewing machine due to the fluid mechanical instability. A variety of stitches-like patterns can be produced, similar to those by the Newtonian fluid mechanical sewing machine, but with more interesting characteristics in the additional third dimension, which creates weakly fused bonds in some patterns. With these bonds, the fabricated fibers exhibit improved toughness in uniaxial tensile test. The toughening mechanism is found to be similar to the one in spider silk — the breaking of sacrificial bonds and the releasing of hidden length contribute significant dissipated energy to the system. However, the mechanical performance of these microstructured fibers is restricted by early fiber breakage as the number of sacrificial bonds increases. Here, we seek to understand the failure mechanisms of the microstructured fibers through tensile tests and finite element simulations. Static and dynamic failure are both found to cause early fiber breakage. These findings are helpful for the design optimization of microstructured fibers with high toughness and ductility, which can find potential use in impact protection and safety-critical applications.

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