Abrasive Wear Failure of SEBS Endoscope

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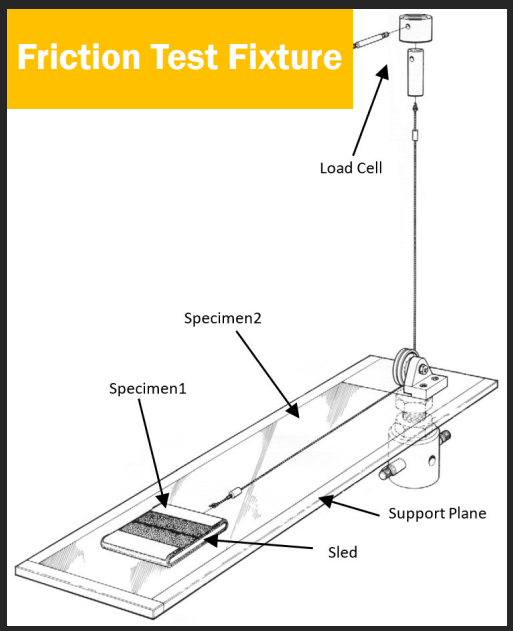
Abrasive wear failure of endoscope after ~200 cycles through storage tube.

Power Tool Grips (Overmolded SBS)

SBS/SEBS are commonly encountered in power tool grips, either alone or compounded with polyurethane. The high surface friction helps to avoid slipping.

Friction Test Fixture



Instron tensile test frame accessory for measuring the dynamic and static coefficients of friction between materials (ASTM D1894-withdrawn 2023 / ISO 8295).

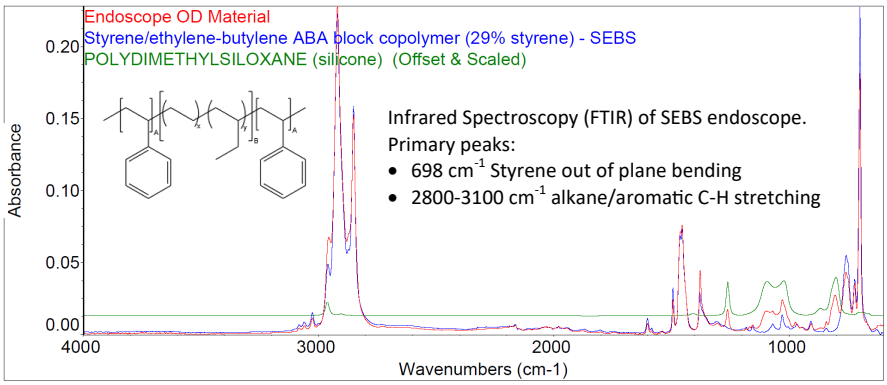
Endoscopes failed electrical leakage tests after device sterilization. Inspection of the failed endoscopes revealed tears in the styrene ethylene butylene styrene (SEBS) device body.

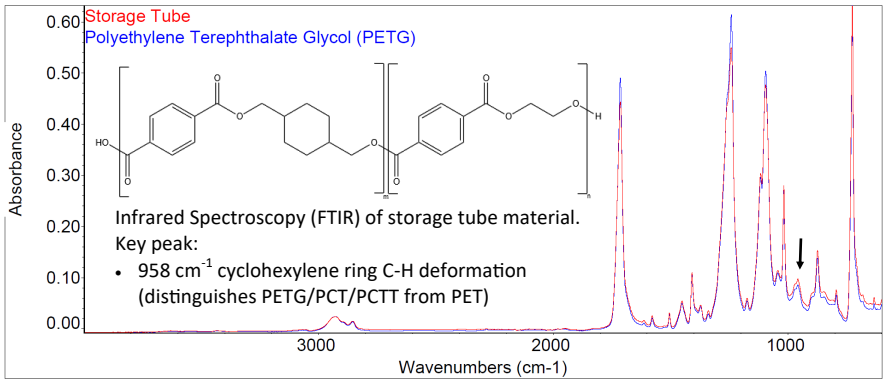
Laboratory recreation of the cleaning process showed excessive rubbing when inserting the device into a third-party storage tube. The SEBS material developed structural failures after ~200 disinfection cycles.

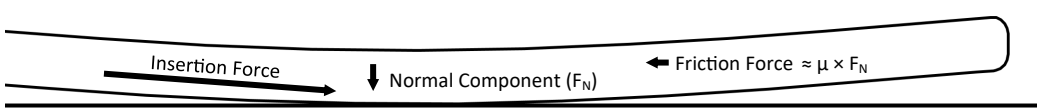
SEBS has very high surface friction. One of the most common uses for this material is the grips of power tools. I was reminded of this case recently when I learned that some synthetic wine corks are coated with SEBS, presumably for holding power in the neck of the bottle. In this case, the high friction SEBS was catching on the inner wall of the storage tube. Whenever the SEBS snagged on the tube the endoscope would buckle, forming a serpentine shape. In the buckled state the endoscope imparts a normal force against the storage tube wall, further increasing the surface friction.

Increasing the insertion force overcame the surface friction. The device then rubbed down the tube wall, creating a loud noise as the surfaces snagged/slipped hundreds of times during each insertion cycle. The rubbing caused through-hole tears in the SEBS endoscope body after approximately 200 insertion cycles. The tears were responsible for the electrical leakage failures.

The failure mode was prevented by using a storage tube with a wider diameter. Eventually the SEBS was replaced with a different material. This is not a complex failure mode, but it serves as a reminder of the need to consider the entire product life cycle when designing for reliability and validating accessories.







Endoscope in storage tube in buckled serpentine state demonstrating how the normal component of the insertion force increases the friction between the SEBS materials and the side of the storage tube (μ = coefficient of friction).