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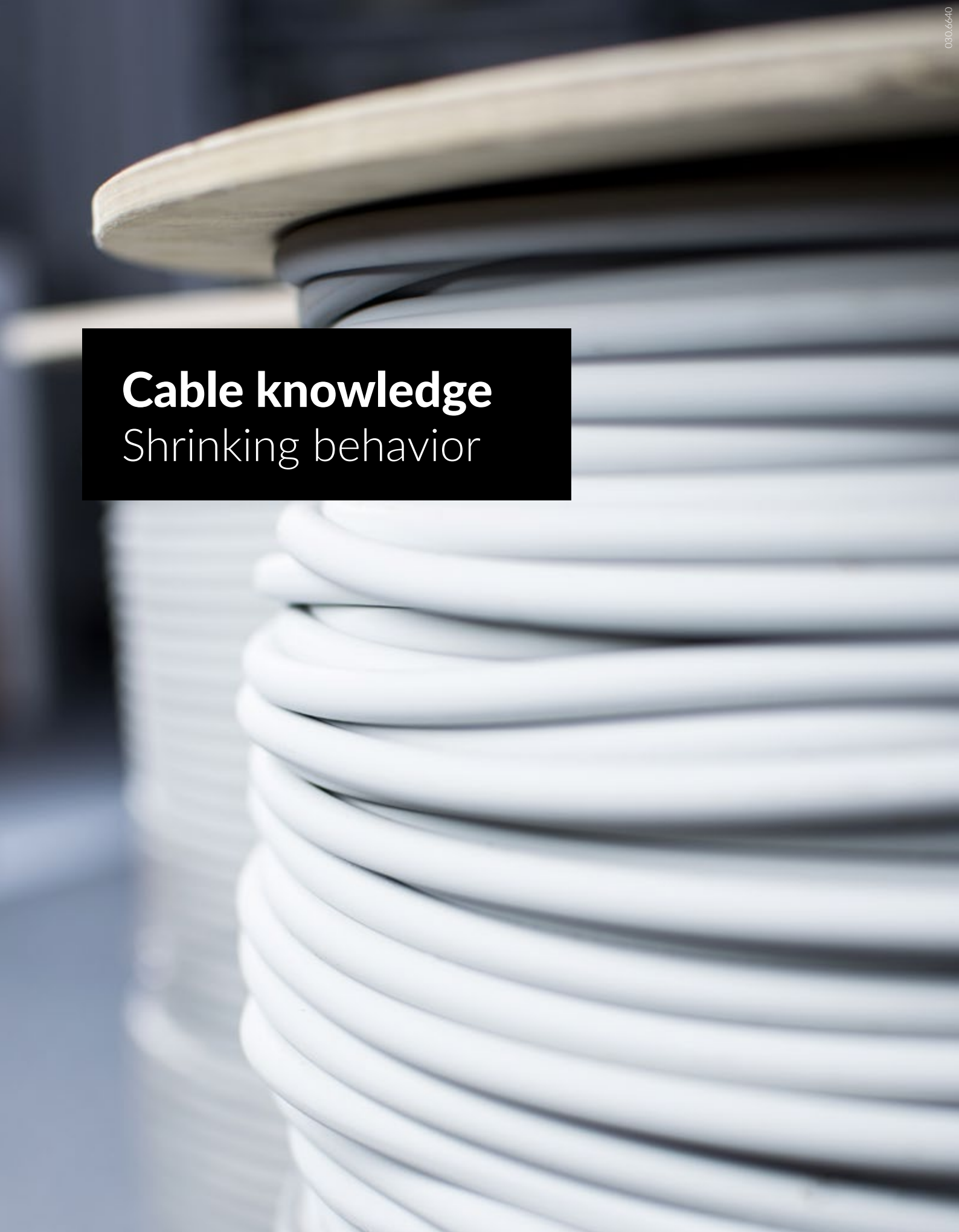


Cable knowledge
Shrinking behavior

Technical Information 2019 – English

R&M

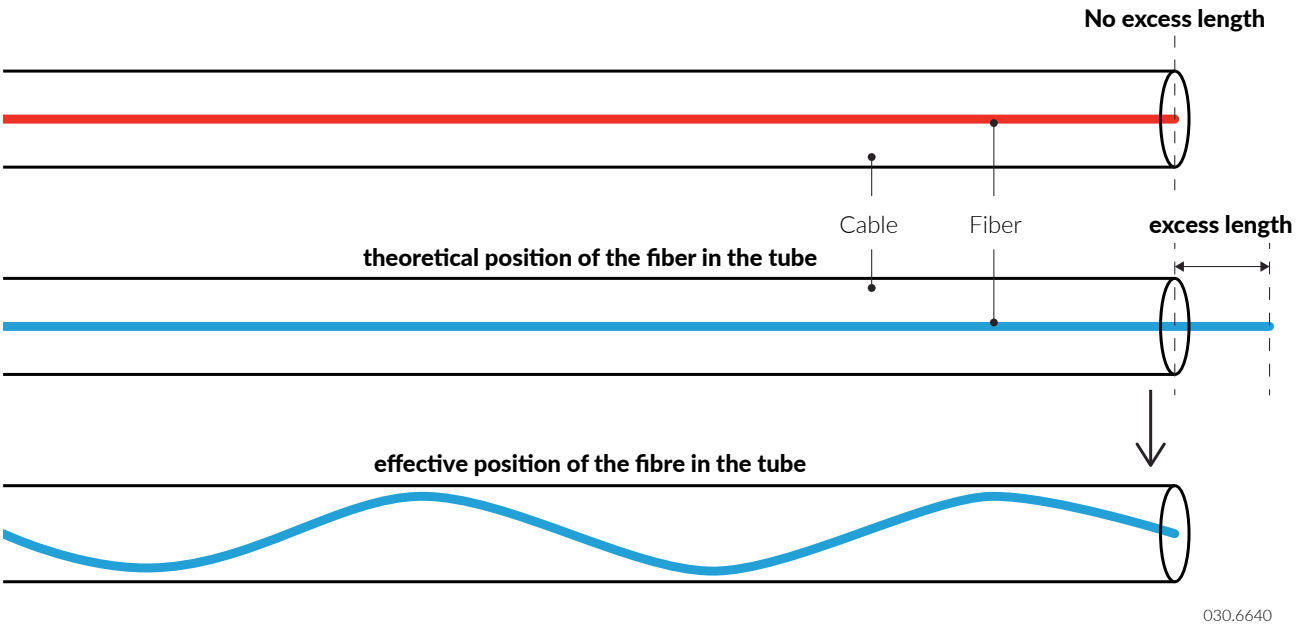
Introduction

Fiber optic cables are designed in such a way that the optical fiber has, related to the cable, excess length. Depending on the cable structure, this excess length is 0.5 to 1.5 %.

The overlength protects the fiber in the event of bending stress or tension on the cable. With both loads, the cable expands locally (bending) or linearly (tension). The excess fiber length protects because the elongation of the cable construction does not immediately affect the fiber.

R&M specifies the specification values for the mechanical loads in such a way that the fiber does not experience any elongation.

Excess fiber length



The disadvantage of the designed fiber overlength is that it increases with cable shrinkage and can lead to undercutting of the minimum bending radii or even to microbending.

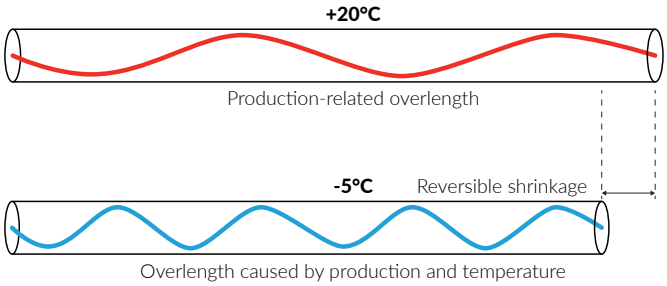
Cable shrinkage

We distinguish between reversible and irreversible shrinkage:

Reversible shrinkage

Reversible shrinkage occurs at low temperatures. The temperature expansion coefficients of plastics are about 50 times higher than those of glass.

When cooling from e.g. +20° C to -5° C, the cable experiences a temperature-related shrinkage of approx. 0.5 %. As a rule, this is not noticeable, since the additional excess length usually «fits» into the cable.



At lower temperatures, however, the additional temperature-induced shrinkage of the cable construction can become noticeable:

- increased hardness of plastics exerts greater pressure
- the cumulated fiber excess lengths of cable construction and temperature can no longer be compensated in the cable

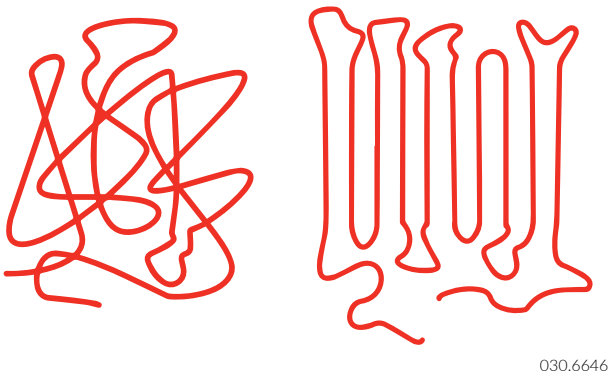
Both effects indicate increasing IL values.

Cable shrinkage due to cooling is reversible because the «original condition» is restored when the cable is heated.

Irreversible shrinkage

Plastics are so-called amorphous materials in which molecules do not follow a structure.

During cable extrusion, the hot plastic is pressed through a die. This produces high shear forces, which force the molecules to align in the longitudinal direction of the cable. Before the liquefied plastic can change back to the amorphous state, it is quenched in the water bath of the extrusion line. The orientation of the molecules in the longitudinal direction of the cable is frozen.



Amorphous state **Semi-crystalline state**

As long as the plastic is not heated above a certain temperature, the so-called gas transition temperature, the semi-crystalline structure is retained. At temperatures above the gas transition temperature, the restructuring into the amorphous state begins. This causes the cable sheath to shrink. This shrinking process is irreversible.

For HDPE the gas transition temperature is approx. 100° C, for FRLSZH it is between 50° C and 60° C.

Loose cable assemblies such as:

- Pigtail fiber
- Simplex cable
- Duplex cable
- Breakout cable
- Minibreakout cable
- Flex tube cable

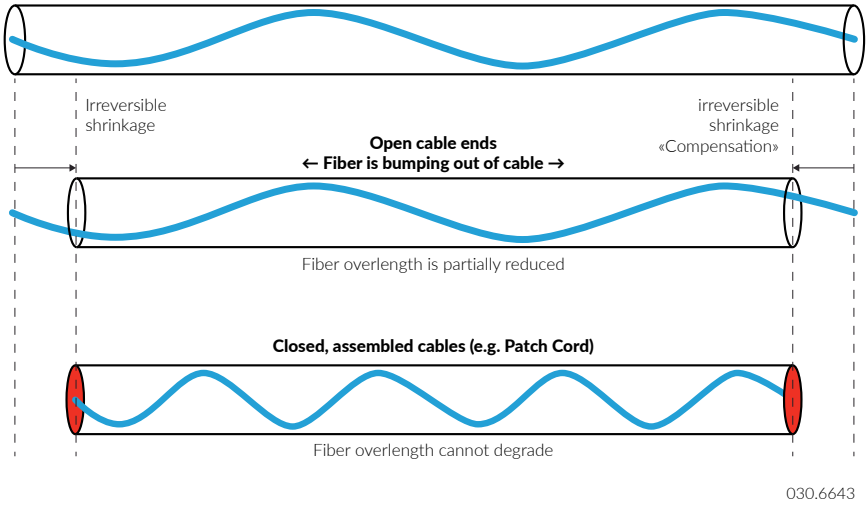
react sensitively to this effect and can shrink by 1 - 5 % depending on the extrusion process.

In principle, the degree of shrinkage depends on the following parameters:

- Material
- sheath cross-section
- extrusion parameters

Cable shrinkage is particularly noticeable with cables fitted on both sides.

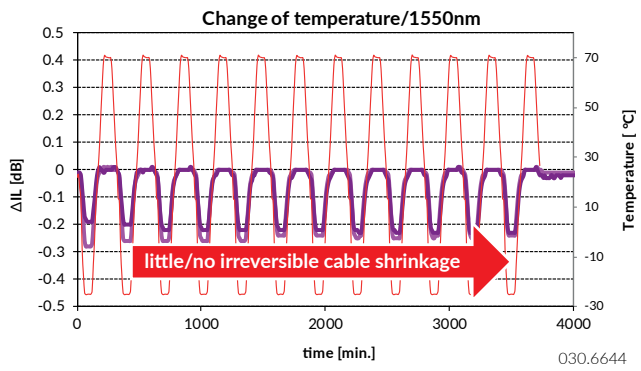
Excess cable length after shrinkage

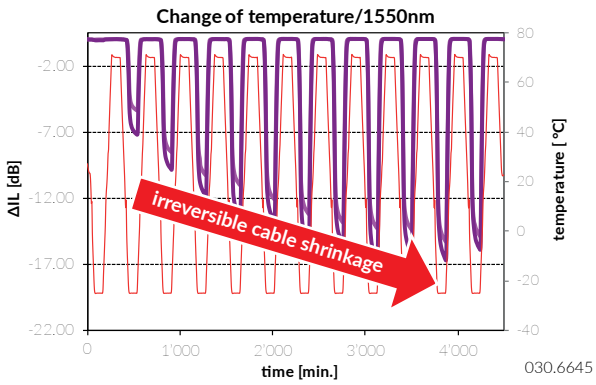


Effect

Cables closed on both sides, e.g. patch cords, may show an increase in attenuation after irreversible cable shrinkage, because both shrinkage effects, reversible (temperature-induced cable shrinkage) and irreversible (structural cable shrinkage) add up and the fiber overlength cannot be compensated anymore.

Too much irreversible cable shrinkage leads to ever higher attenuation over the cycles of the temperature cycling test.





Behaviour of low shrinkage cable

Low shrinkage cables have low irreversible shrinkage at increased temperatures. In the temperature cycling test, the attenuation deviations are stable over the entire duration of the test.

Behaviour of cable sensitive to shrinkage

With each high temperature cycle in the temperature cycling test, the cable continues to shrink. This leads from cycle to cycle to higher attenuation values at low temperatures.