

Optical Gel Characteristics Of Panduit® OptiCam® Connectors

Purpose

The purpose of this document is to familiarize the user with the optical index of matching gel used in Panduit® OptiCam® Pre-Polished Cam Connectors. The optical gel acts as a medium for which the light can pass between the two ends of the fiber. Optical gel has a refractive index very close to that of the fiber core making a nearly seamless connection that results in minimal loss.

Background

There are several different ways to reduce reflection and insertion loss between fiber optic components. One of the quickest and most reliable ways is to utilize an index matching fluid or index matching optical gel deployed between cleaved ends of two optical fibers. Index matching fluids are prone to leakage, evaporation and mechanical instability, and have been replaced in mechanical splices and pre-terminated connectors (such as OptiCam® Connectors) by optical gels. Optical gel is a clear, stable, long shelf life material that has a wider operating temperature range than matching fluids, and hence, has become the industry standard in these applications. Optical gels have a typical shelf life of approximately 30 years.

Index of Refraction (IOR) or refractive index is defined as the ratio of light velocity in a vacuum to its velocity in a given transmission medium (in this case the core of the fiber). The manufacturer of the glass within the fiber optic cable defines the IOR for that specific glass (as a function of fiber design and manufacturing process). The typical IOR for doped silica glasses (in typical multimode and singlemode fibers) is approximately 1.46. Optical gel is engineered to match the refractive index of the fiber as closely as possible.

Fresnel reflection occurs as light is reflected from the cleaved or polished end of a fiber because of the difference of refractive indices of air and glass. The optical gel acts as a matching medium between the two cleaved or polished ends of the fiber minimizing the reflections and therefore minimizing the loss. Without the gel (or with a gel that did not closely match the IOR of the fiber being mated), the reflections would be severe (low return loss) and could cause significant loss of light (high insertion loss).

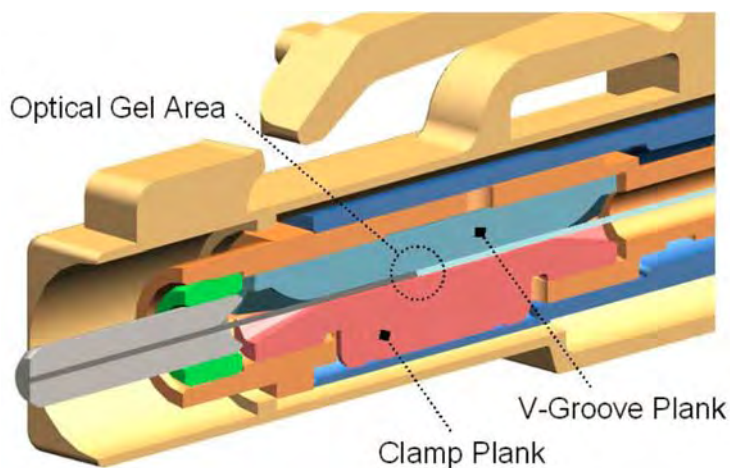


Figure 1 – Typical OptiCam® Connection Engine in the Fiber Interconnect Area

OptiCam® Index Matching Gel Specifications

Panduit® utilizes a 'thixotropic' optical coupling gel (a gel that has material characteristics that resist flow) in OptiCam® Connectors. This product meets the very stringent requirements placed on such gels for use in the outside plant environment (Telcordia GR-2919-CORE).

This is a non-curing gel with a very low viscosity and a refractive index that matches the core index of fibers that are deployed in OptiCam® Connectors. The IOR of this gel is chosen such that core index matching occurs at the operating wavelengths of interest (IOR for gels of this type is dependent on the wavelength).

See Table 1 below.

<i>Operating Wavelength</i>	<i>Typical Refractive Index</i>
850nm	1.448
1310nm	1.439
1550nm	1.438

Table 1 – Typical IOR Values at Different Wavelengths for Thixotropic Optical Gel

Characteristics of the Thixotropic Optical Gel are matched to the requirements of OptiCam® Connector applications. These characteristics are shown below in Table 2.

<i>Typical Characteristics</i>	<i>Typical Value</i>
Color, Appearance	Crystal clear
Optical Absorption (450 – 750nm)	Less than 0.0003% per μm
Apparent Viscosity	11,000cP (centipoise)
Oil Separation (24 hrs at 100°C)	0.1%
Evaporation (24 hrs at 100°C)	Less than 0.2%
Thermal Coefficient of Expansion	$6.0 \times 10^{-4} \text{cm/cm/}^{\circ}\text{C}$

The low viscosity of the gel provides some strain relief between the mated fiber endfaces as they are exposed to different environmental extremes in the form of temperature changes and/or mechanical shock/vibration. This gel is deployed at the end of the fiber stub in the connector (in the factory) and because of its thixotropic nature and the design of the OptiCam® Connector, it will not migrate while sitting on the shelf (unterminated) or while deployed in the field.

Summary

Panduit® has chosen a thixotropic gel as the optical refractive index matching medium to be used in all OptiCam® Pre-Polished Cam Connectors. This non-curing, low viscosity, high temperature, long shelf life gel variant has been designed to meet Panduit® high specification requirements for pre-terminated connectors. This material enables OptiCam® Connectors to be deployed in a variety of environmental conditions within the premise and assures that the product will exceed the standards expectations of TIA/EIA-568-B.3.