

**Report on product specifications****According to Telcordia GR-1312-CORE Generic Requirements for OFAs and Proprietary DWDM Systems Issue 3, April 1999**

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## 1 Product: Erbium Doped Fiber manufactured by Direct Nanoparticle Deposition (DND)

Fiber code: LF2400

## 2 Summary of test results

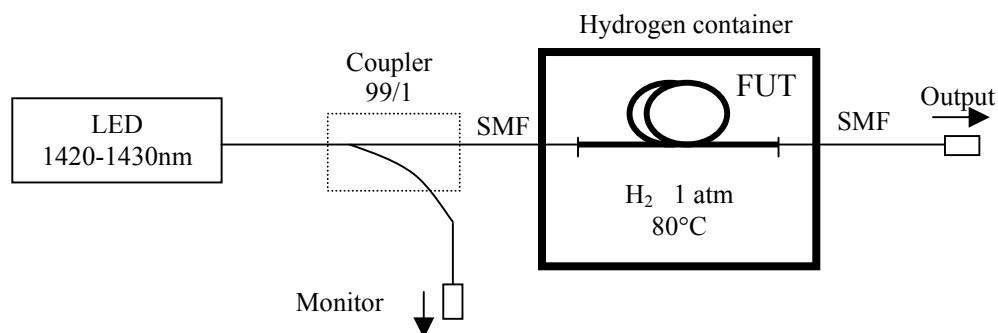
Under the mentioned requirements and specifications, the erbium doped fibers manufactured by DND are qualified as follows:

<0.17dB increase in absorption (1420-1430nm) of 2m of LF2400 when the fiber is exposed to H<sub>2</sub> at 0.01 atmosphere partial pressure over 20 years at 80°C

## 3 Hydrogen contamination test

This test determines the increase of attenuation between 1420-1430nm when the fiber is exposed to hydrogen-contaminated environment.

### 3.1 Test set-up



FUT: LF2400

- Fiber length: 2m
- Total fiber absorption at 1530nm: 80dB

### 3.2 Environmental test conditions

- Hydrogen pressure: 1atm
- Hydrogen temperature: 80°C

### 3.3 Test preparation

- The fiber under test is spliced in between 99% coupler's pigtail and output connectorized pigtail. The splices are sleeved.
- The FUT is arranged inside the container on a loose loop of 20cm diameter and do not touch any metal part of the container. The sleeved splices are fixed inside the container. Less than 1m of SMF are inside the container.
- The container is sealed and then vacuum is created inside the container.
- The container is filled with hydrogen.

- The gas temperature is raised to 80°C
- The hydrogen pressure is tuned to 1 atmosphere
- The pressure and temperature inside the container is monitored throughout the test

### 3.4 Measurements

- LED source is switched on
- The monitor pigtail is connected to optical spectrum analyser (OSA) and the spectrum between 1420 and 1430nm is recorded
- The output pigtail is connected to OSA and the spectrum is recorded
- The absorption is calculated using the formula:

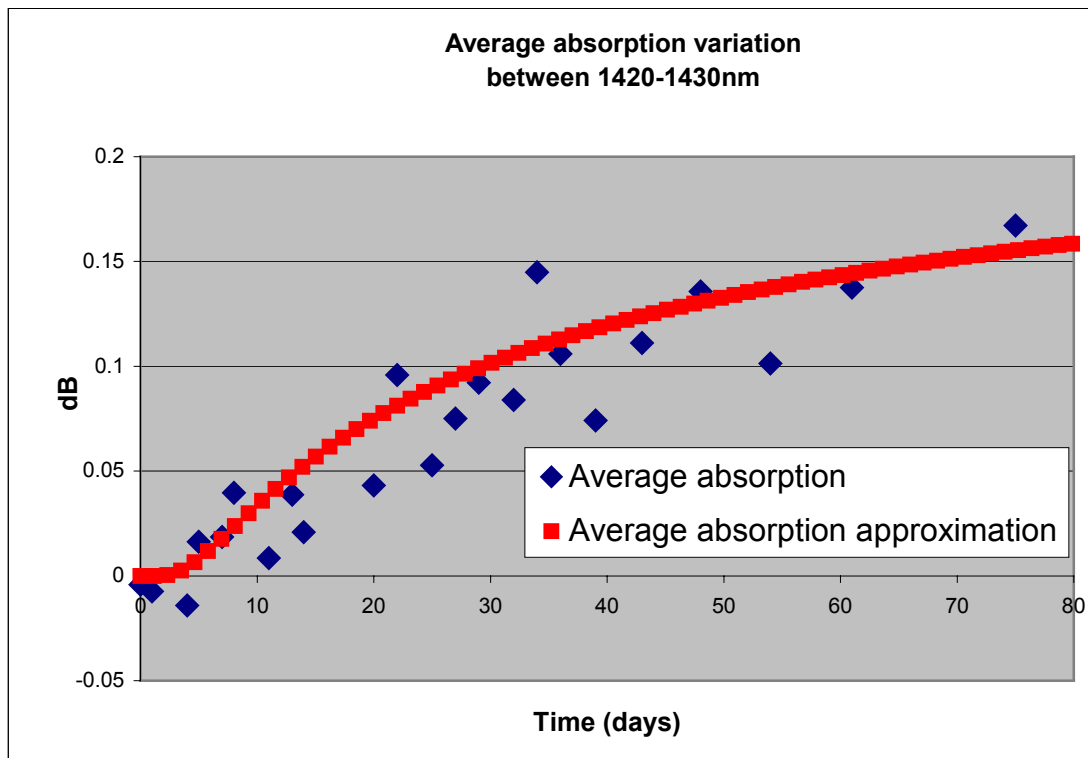
$$Abs(\lambda) = P_{out}(\lambda) - [P_{mon}(\lambda) + 20] \quad dB$$

where  $P_{out}(\lambda)$  is the output power in dBm/nm,  $P_{mon}(\lambda)$  is the monitor power in dBm/nm,  $\lambda$  is the wavelength between 1420-1430nm in 1nm steps.

- The measurements have been made for 75 days, about twice a week: total 23 measurements.

### 3.5 Results

For each measurement, the average power is calculated over the spectral range 1420-1430nm. Considering the average absorption measured at the beginning of the test as a reference, the average variation in time is presented below (blue dots):



The red dots represent the following approximation function:

$$\Delta Abs = k_0 \cdot \operatorname{erfc}\left(\frac{k_1}{\sqrt{C_{H_2} \cdot t}}\right)$$

where  $k_0$  and  $k_1$  are constants,  $C_{H_2}$  is the hydrogen concentration in the container,  $t$  is time and  $\operatorname{erfc}(x)$  is the following function:

$$\operatorname{erfc}(x) = \frac{2}{\sqrt{\pi}} \int_x^{\infty} e^{-y^2} dy$$

The 0.17dB increase in absorption induced by 75 days of exposure to H<sub>2</sub> at 1 atmosphere is equivalent to 0.17dB increase in absorption induced by

$$\frac{75 \cdot 1}{0.01} = 7500 \text{ days} = 20.5 \text{ years}$$

of exposure to 0.01 atmosphere partial pressure.

To allow a generous margin we can conclude that a maximum 0.17dB increase in the absorption between 1420-1430nm is obtained when 2m of LF2400 fiber is exposed to hydrogen at 0.01 atmosphere partial pressure over 20 years at 80°C.