Technical University of Lodz

Department of Semiconductor of Optoelectronics Devices

Laboratory of Optoelectornics

Instruction 3

Measurement of the influence of fibers optisc macrobending on their attenuation.

1. Goal

In this exercise students can analyze an influence of the macro- and microbending on the single mode optical fibers attenuation which is a main parameter characterizing optical fibers. Students will analyze two types of single mode fibers: standard with fluorine doped cladding and "Clear Curve ™" - fiber of microstructures.

2. Theory

Bending the fiber causes loss of infrared radiation energy. Taking onto account the bending angle we can distinguished two types of bending: macrobendig (bending) when the radius of curvature is much bigger then the fiber diameter (> 10 mm) and microbending, with a small radius of curvature, caused as an incidental microscopic bending on small local, lateral displacements of fiber surface. Radiation energy losses in first type of bending can be devived into pure bending losses and the losses of mods conversions. They cause refractive index changes in the bending area, which can lead to the formation of leaking modes (Fig. 1a). The second type of bending – microbending – causes mods blurring in single-mode fibers, unwanted mods coupling in multi-mode fibers and energy transition from basic mods to higher mods (Fig. 1b).

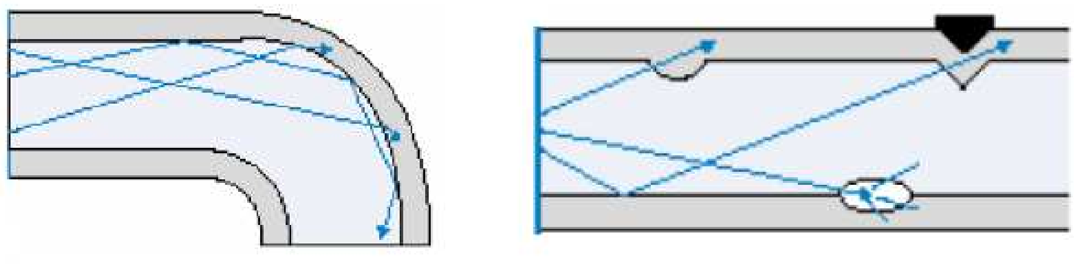

Fig.1 a. Macrobending b. Microbending

Losses resulting from bending are rather small, of the order of dB/km at carefully made and placed optical fiber cables, but in adverse conditions they may be greater then 1dB/km. The amount of losses caused by bending or microbending is a parameter which determine the class of the amplitude optical fiber sensors, so-called, microbending sensors.

The impact of macrobending is particularly important in the FTTH networks (Fiber To The Home), where the bending angle is big with a small radius. To improve the fiber bending strength is necessary to reduce the refractive index. It can be achieved by using appropriate impurities, and their proper distribution in optical fiber, we can see it in fluorine doped cladding optical fibers. Moreover, to decrease the refractive index are used HF - Hole Fibers (Fig. 2) – fibers with empty holes seen in the fiber cross section. In this case the role of impurities fulfill the regular air gaps. The disadvantage of this type of fiber is the lack of compatibility with standard optical fiber and the complexity of their structure.

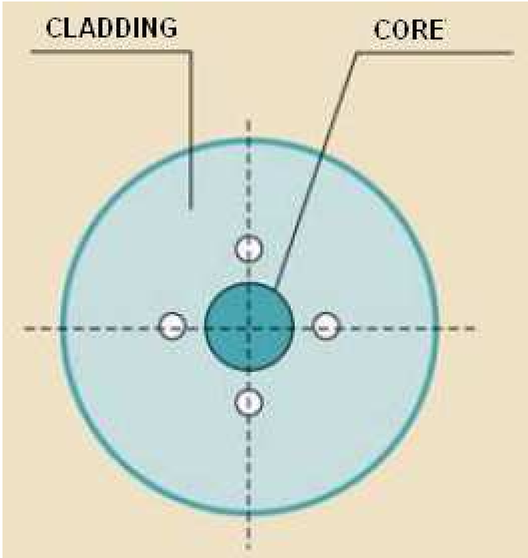

Fig.2 Hole Fiber (http://itpedia.pl/index.php/Grafika:OP8.jpg)

Another solution to reduce the refractive index is to put the appropriate mesh structure in the fiber claddinfg (eg Clear Curve). This solution allows the use of optical faiber in FTTH networks,because the macrobending losses are vary small,no more then 0,1dBm (see Fig. 3)

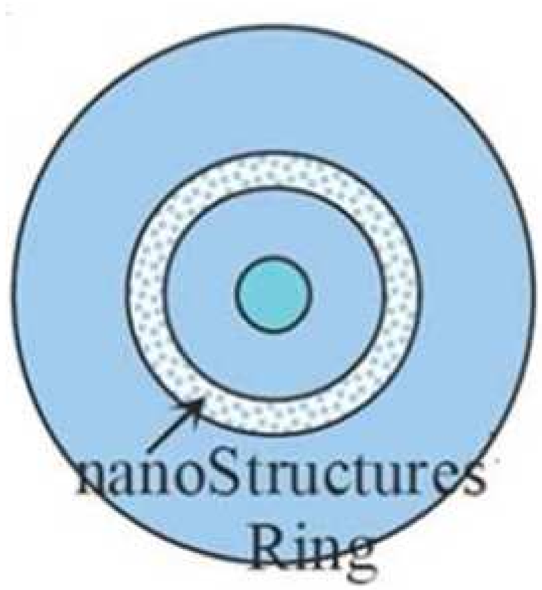

Fig. 3 Clear Curve. (http://www.fiberoptics4sale.com/wordpress/corning-bend-insensitive-fiber-corningclearcurve-single-mode-and-multimode-fibers-wow/)

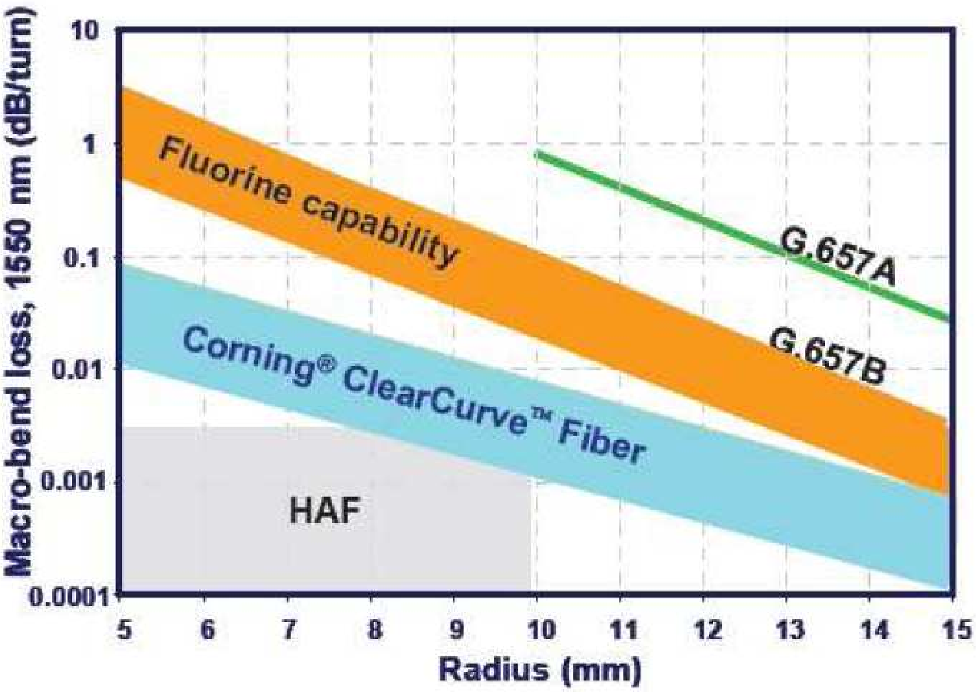

Fig. 4 Attenuation caused by macro bending as a function of bending radius. (http://pro.corningfiber.com/docs/opticalfiber/ClearCurve%20brochure_Polish.pdf)

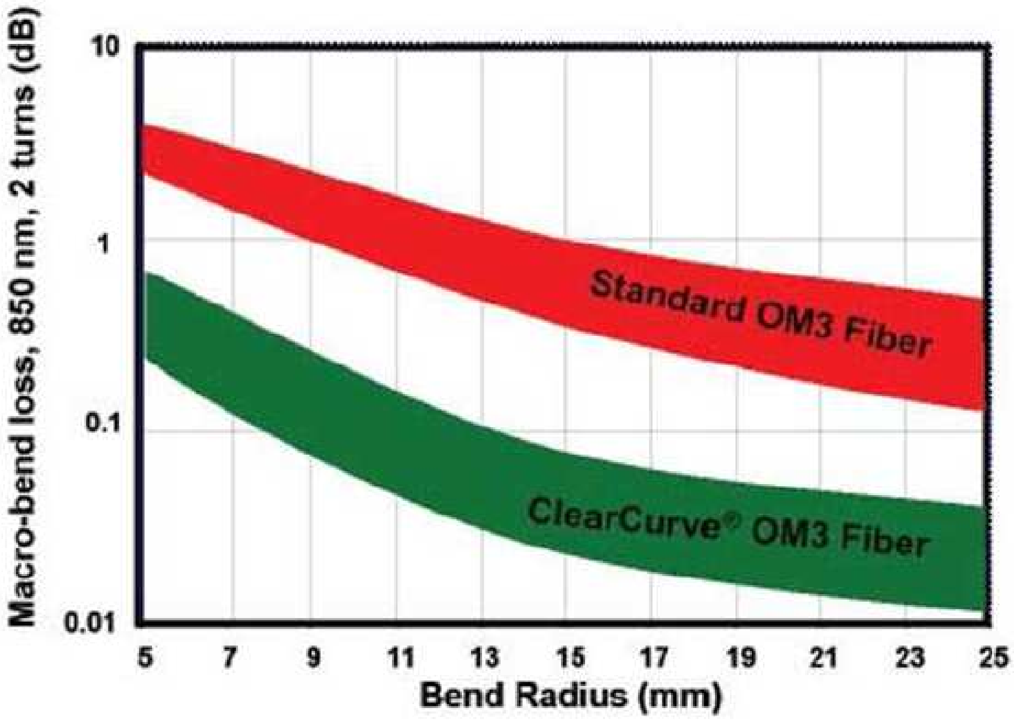

Fig. 5 Comparison of Macro-bed loss of the standard OM3 fiber and in Clear Curve fiber as a function of bend radius.. (http://blog.fiberinstrumentsales.com/tag/clearcurve/)

3. Exercise

<u>Measuring the influence of one 360° turn of the optical fibre on its attenuation.</u>

1. Ask the teacher about the meter Anritsu ML93B, light source and optical fibers.

WARNING! During the calibration and measurement do not look into the optical fiber connectors or the output of light sources!

2. Before placing the fiber into input or output of detector check the fibers front using microscope.
3. If you will find any impurities – clean fibers front by using the tissue with alcohol.
4. After re-checked, connect the fiber with the meter and with light source (OTDR), according to the below diagrams.

WARNING! Connection between OTDRs output and the meter do ONLY the teacher!!!!!

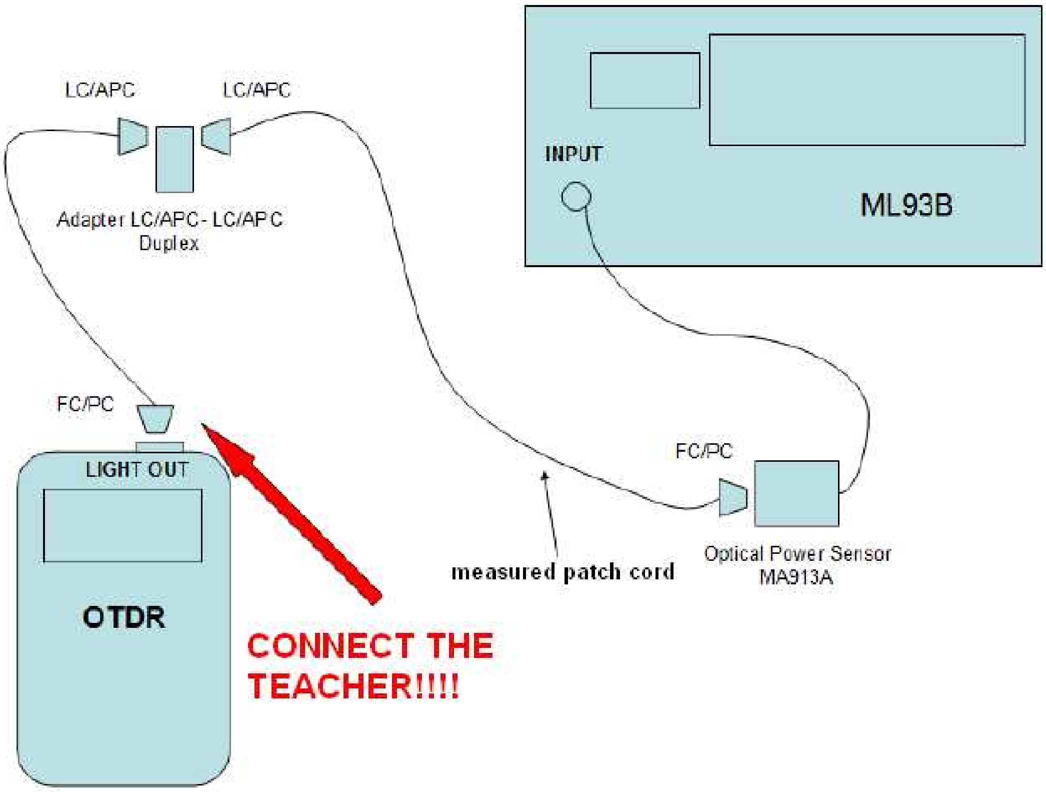

Fig. 6 Schematic diagram of the standard optical fiber connection.

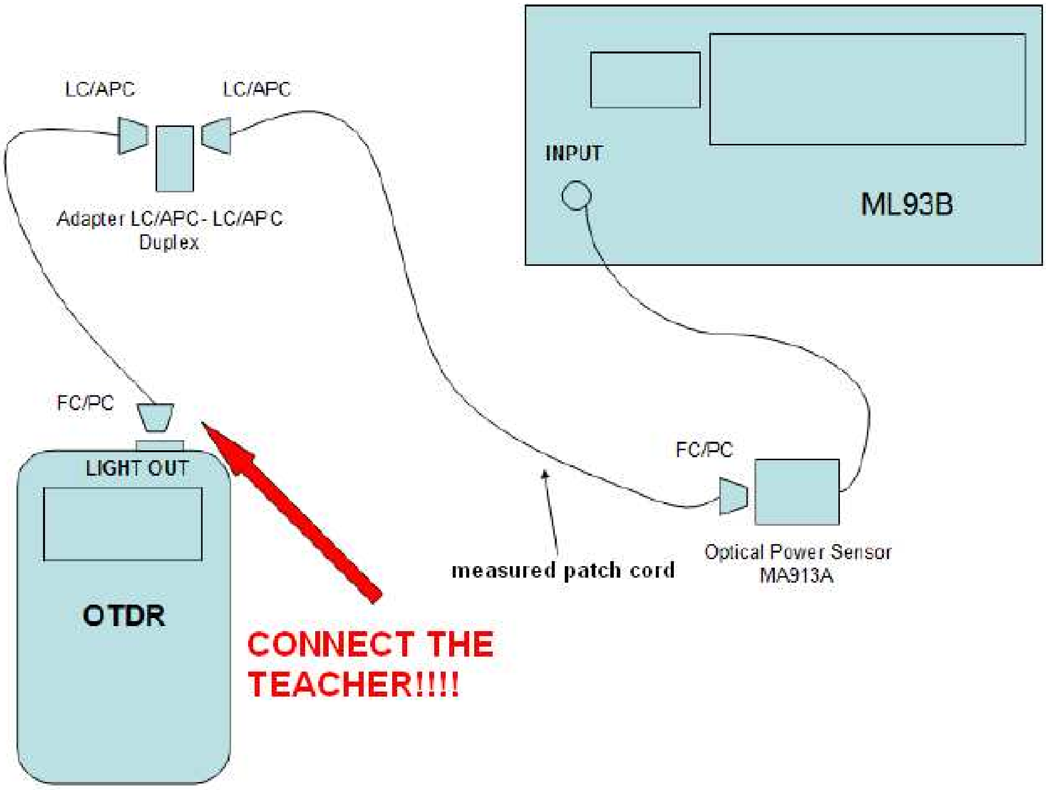

Fig. 6 Schematic diagram of the standard optical fiber connection.

5. Turn on the meter by switching the "POWER" to "AC".
6. Calibrate the meter with the "REL" in the "MODE" section.
7. Ask the teacher to turn on the light source with the wavelength of 1310 nm.
8. Wind the test fiber on the gaps of “measurement tree”.

WARNING! For the standard fiber do not make measurements of the three smallest loops to avoid breaking of fiber.

9. Ask the teacher to change the wavelength to 15 50 nm.
10. Make measurements again by points 5-8 (except point 7).
11. Make measurements according to the above points for the fluorine doped fiber and "Clear Curve ™".
12. After each part of measurements turn off the meter and disconnect the test fibers. The ends of the fibers, the sensor input and the source output have to be immediately secure the plastic cover to avoid the damages.

Measuring the influence of ten 360° turns of the optical fibre on its attenuation.

Repeat the all points from the previous part of exercise, bending the fibres 10 times.

4. Raport

The report should include:

- The results of measurements in the form of tables.
- The general conclusions and observations from exercise.
- Comparison of obtained results with the standards of ITU-T G.652 and ITU-T G.657.