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A METHOD TO REMOVE OPTICAL FIBERS COATING

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In this paper we report some experimental results concerning the stripping in any portion of the optical fibers at 10.6 µm wavelength. These experimental procedures have been performed using a CO_2 laser with 40 W power and a galvanometer scanner with 150 mm focal length. The objective of this paper was to find the optimal conditions (speed of the laser along the optical fiber) for a good stripping by means of the laser, without damaging the optical fiber.

Keywords: optical fiber, multimode optical fiber, optical fiber stripping, CO_2 laser.

1. Introduction

The optical fiber is an optical waveguide with circular section and consists of a cylindrical central dielectric core clad by a material of slightly lower refractive index (Fig. 1). As can be seen from the Fig. 1, the cladding is coated by a polymer that offers mechanical and chemical protection. These coatings are made from acrylate composite materials applied to the outside of the fiber during the production process.

Optical fibers can be stripped mechanically, chemical or thermo-mechanical. The mechanical and thermo-mechanical methods were applied for end stripping of the optical fibers. The chemical method uses acids to remove the fiber's acrylate coating and permits to remove the coating from any portion of the optical fiber. But, the disadvantage of this method is that exist the possibility of chemical solutions to enter into the space between the cladding and coating and this fact can have serious consequences in time, causing damage of the core.

Thus, in this paper we present some experimental results concerning the stripping in any portion of the optical fiber using a CO_2 laser with 10.6 µm wavelength and 40 W power coupled to a galvanometer scanner without damaging it.

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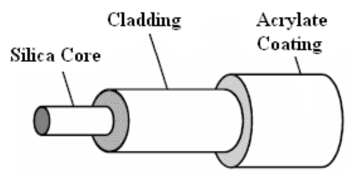

Fig.1. Optical Fiber Structure.

The structure of the paper is the following: in Sect. 2 we present the objective of this paper and the motivation to perform this experimental procedure and in Sect. 3 we report the experimental procedure and discuss the obtained results. The conclusions of the paper are outlined in Sect. 4.

2. Motivation

In present, the optical fiber plays a very important role in the telecommunication and sensing fields being used in diverse applications. Optical fiber sensors technology is in full development in the last years. Different implementations based on various physical principles and for a wide range of applications have been reported in the literature [1-5]. Optical fiber sensors offer numerous advantages over conventional sensing technologies such as high sensitivity, very small size, complete immunity to electromagnetic interference and can operate in high temperature environments.

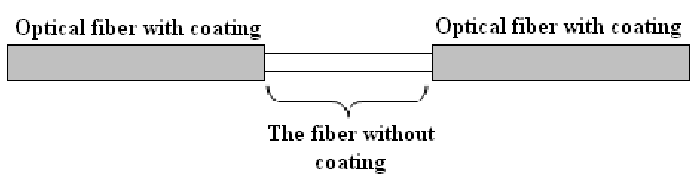

Fig. 2. A portion of the optical fiber without protection.

Due to the high sensitivity of the optical fiber when to act a pressure on it, frequently is used as a sensor [3]. When a pressure acts on the optical fiber the polarization state in the fiber is perturbed and so changes the value of the power transmitted from the fiber. Thus, based on this principle, we investigate the possibility to realize an interferometric fiber-optic pressure sensor which is based on the Michelson interferometer. In this case, the sensing optical fiber arm of the interferometer is used as fiber-optic pressure sensor. To increase the sensitivity at the pressure we needed to remove the optical fiber coating on a portion (more precisely, in our case, at the middle of the fiber). The principle is showed in Fig. 2.

For this reason we have performed several tests to remove the coating of the optical fiber without damaging it by using the above described laser system. One main advantage of using this laser system is that we can strip the fiber in a controlled manner as we will see further.

3. Experimental procedure and results

As explained in the section 2, the objective of this work has been to remove the coating of the optical fiber without damaging it, in order to increase the sensibility at the pressure. To remove the coating of the optical fiber we have used a CO_2 laser coupled to a galvanometer scanner. We performed many tests at different scanning speed of the laser over the optical fiber.

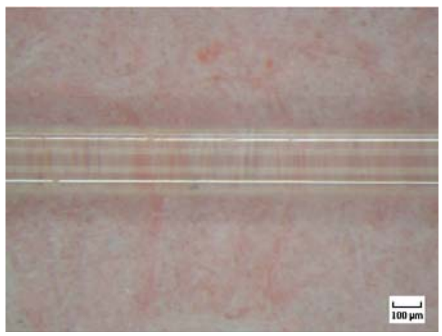

Fig. 3. The image of the multimode optical fiber before testing.

The image of a multimode optical fiber before testing, which parameters were: core diameter $62.5 \pm 3\ \mu m$, cladding diameter $125 \pm 2\ \mu m$ and coating diameter $245 \pm 20\ \mu m$, is presented in Fig. 3. The microscopic study of the stripped optical fiber was performed with a Stereomicroscope Olympus SZX7 equipped with acquisition and image processing software. From the microscopic images we obtained the information regarding the quality of the stripping.

In Fig. 4 we report several images with multimode optical fiber at different scanning speed of laser focalized spot over the optical fiber. As can be seen from the images, we have obtained good results for scanning speed of the laser between $0.6\, m/\min$ and $3\, m/\min$, keeping the laser power constant (Figs. 4 a), b), c), d) and e)). The obtained results encouraged us to apply this method on other types of optical fibers.

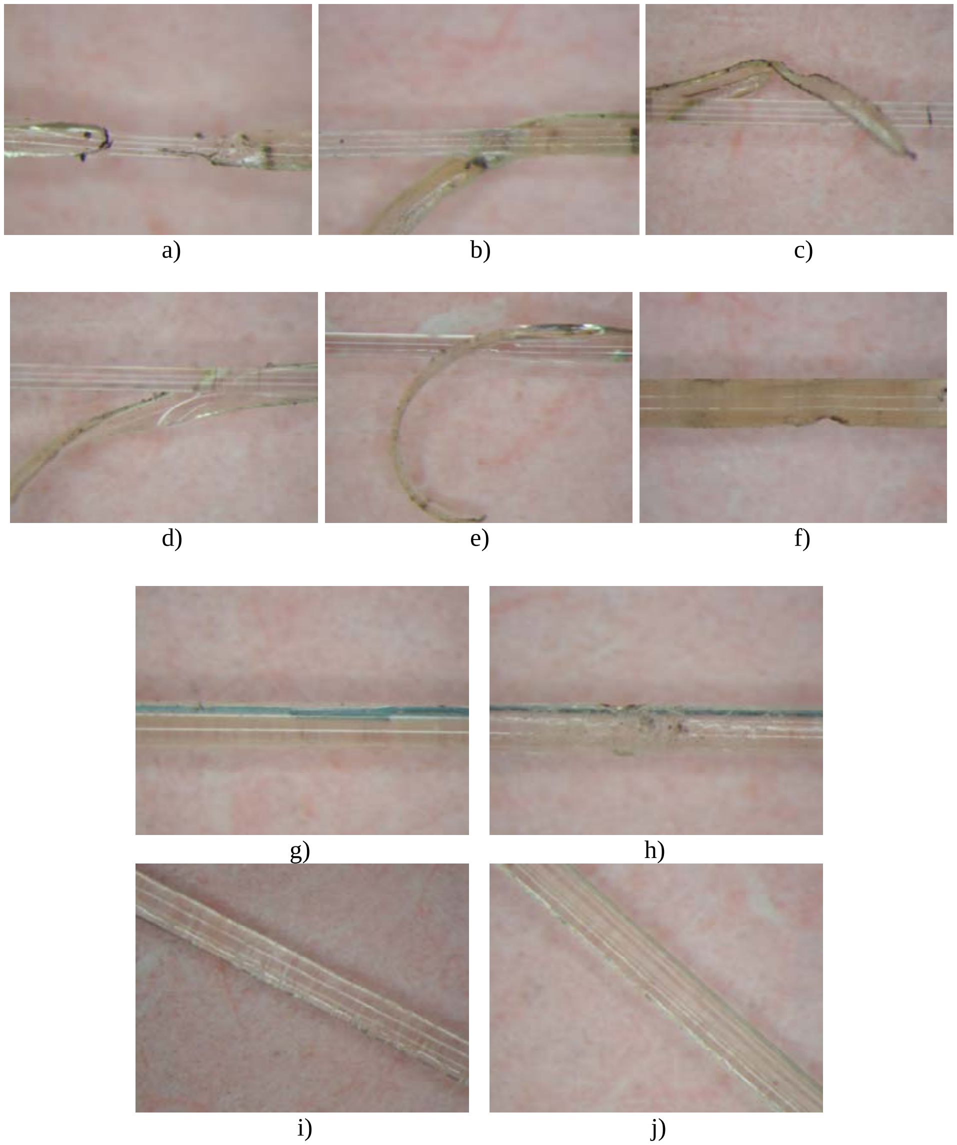

Fig. 4. Microscopic images of the multimode optical fiber stripping at different scanning speed of the laser: a) $v = 0.6\ m/\min$, b) $v = 1.2\ m/\min$, c) $v = 1.8\ m/\min$, d) $v = 2.4\ m/\min$, e) $v = 3\ m/\min$, f) $v = 6\ m/\min$, g) $v = 12\ m/\min$, h) $v = 18\ m/\min$, i) $v = 24\ m/\min$, j) $v = 30\ m/\min$.

As can be seen from the Figs. 4 f), g), h), i) and j), for scanning speeds between $v = 6\ m/\min$ and $v = 30\ m/\min$, the optical fiber coating can't be complete removed. In these cases the laser beam passed transversal over the optical fiber. Thus, from the microscopic images we obtained the information regarding the depth of penetration in the optical fiber coating.

For high scanning speed (greater than $v = 24\ m/\min$) the laser beam hasn't effect on the optical fiber coating and for speed values less than $0.6\,m/\min$ the laser beam damage (Fig. 5) or cut the optical fiber.

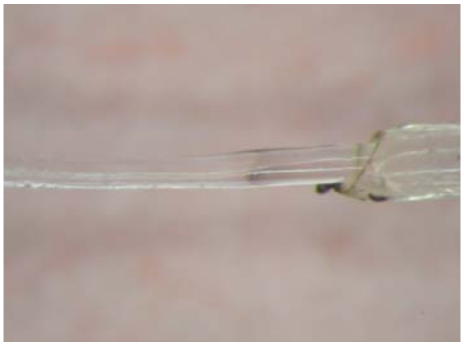

Fig. 5. The image of the damaged optical fiber at a scanning speed of the laser less than $v = 0.6\ m/\min$.

Finally, in Fig. 6 we present the depth of penetration in the optical fiber coating versus scanning speed of the laser. The depth of penetration decreases with the increase of the scanning speed of the laser.

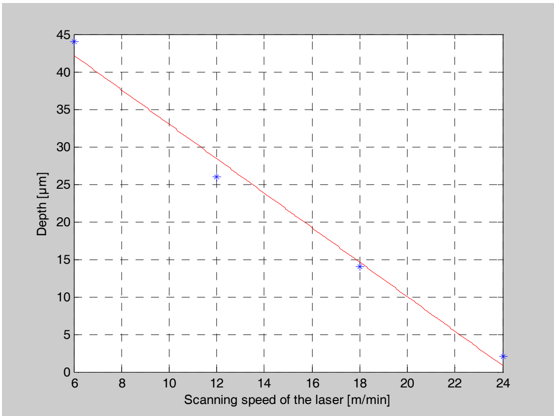

Fig. 6. The depth of penetration in the optical fiber coating versus scanning speed of the laser.

Thus, this laser-based process offers several advantages over the conventional stripping methods. The main advantages of this stripping laser process are: the laser beam can be directed in any portion along the optical fiber, is a non-contact process and the laser beam can be precisely controlled.

4. Conclusions

Based on CO_2 laser with 10.6 µm wavelength and 40 W power, coupled to an galvanometer scanner, we obtained good results to remove the optical fiber coating for scanning speed of the laser between $0.6\,m/\min$ and $3\,m/\min$. When the scanning speed was varied between $6\,m/\min$ and $24\,m/\min$, the depth decreases with increasing of the scanning speed. If the speed is greater than $24\,m/\min$ the laser beam hasn't effect on the optical fiber coating and for the scanning speed of the laser less than $0.6\,m/\min$ the laser beam damage or cut the optical fiber.

The microscopic study of the unprotected optical fiber was performed by means of the Stereomicroscope Olympus SZX7 and from these images we obtained the information regarding the quality of the stripping.

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R E F E R E N C E S

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