11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM 2009

One step core-shell optical fiber obtained by bottom-up process: AFM analysis

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Abstract – Core-shell optical fibers have been produced by one-step process, by a bottom-up Ag^0 shell self-growth formed on the fiber pulled directly from the melted $PbF_2 – GeO_2 – Al_2O_3$:Ag glassy starting material. AFM images are presented to characterize the surface nanoshell formed by a metallic nanofilm obtained by the reduction of silver ions, growth and migration of silver nanoparticles up to the fiber surface annealed around T_g. The goal of this kind of fibers is to act as an active part in photonic nanodevices.

We have produced and studied hybrid nanocomposites obtained by a bottom-up process starting from glassy materials from the system PbF_2–GeO_2–Al_2O_3 doped with Ag_2O or AgF. Thermal treatment around the glass transition temperature (T_g) allowed us to control the roughness of the self-growth thin film of Ag^0 formed by reduction, growth and migration of silver nanoparticles up to the glass surface. We have performed molecular dynamics simulations analysis and experimental measurements to evaluate kinetic parameters related to these glassy systems, to improve technological applications [1,2]. Kinetics parameters and fiber drawing have also important correlations for applicability of the fiber drawing process.

In the present work we have developed a core-shell optical fiber in one-step process, produced by the same mechanism: a bottom-up Ag^0 shell self-growth is formed on the fiber pulled directly from the melted PbF_2–GeO_2–Al_2O_3:Ag glassy starting material under T_g. The thickness of the nanostructured metallic shell is controlled by the annealing time.

The scheme representing the fiber fabrication is shown in figure 1-A, and AFM images are presented to compare the fiber surface before and after the shell self growth: fig. 1-B shows the fiber surface without thermal treatment, while fig 1-C shows the nanostructure formed by the metallic nanofilm formed around the same fiber, as a shell, after 3 h of annealing at 280℃ under air atmosphere.

Changes in morphology of this fiber, observed by AFM, were analyzed as a function of time of thermal treatment and atmosphere.

The metallic reflectivity obtained in the final fiber surface allowed us to use the formed nanostructure as a nanoshell in a core-shell type fiber, as proposed previously in our group [3]. The dielectric properties of such metallic nanostructures were also reported previously [2].

The aim of the present work is to use these data to improve the control of the shell formed solely whit thermal treatment. The final goal of this kind of fiber is to act as an active media in integrated systems, including surface plasmons processes in photonic nanodevices for health and environment control applications.

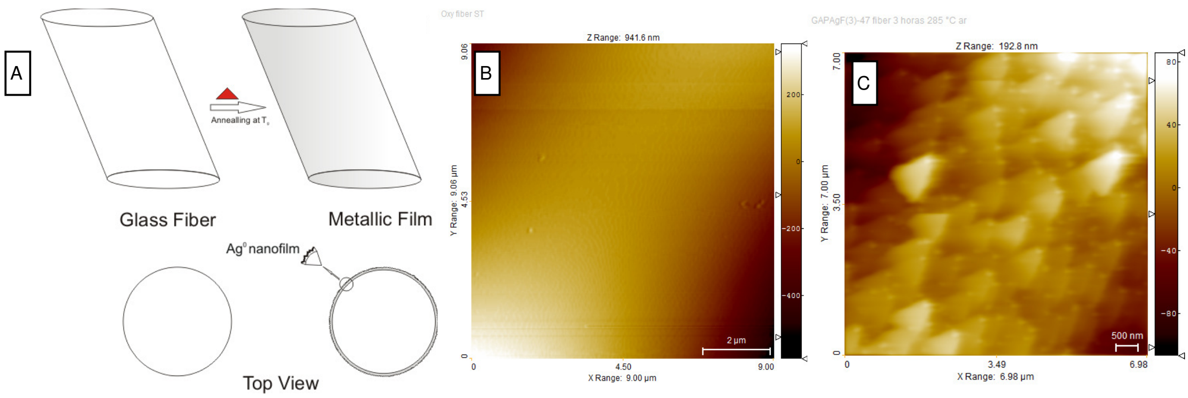

Figure 1: A) Scheme of the nanoshell growth; **B)** AFM image of the fiber surface without thermal treatment, and **C)** fiber surface after 3 h of annealing at 280℃ under air atmosphere.

References

[1] R. Schneider. Materiais híbridos formados por nanofilmes moleculares depositados sobre nanofilmes metálicos produzidos por processo bottom-up em substratos vítreos para uso como parte ativa de nanodispositivos, Dissertação de Mestrado, Universidade Federal de Pernambuco, 2008.
[2] S. R. Santana, F. S. L. Borba, G. G. Pedrosa, P. A. Santa-Cruz and R. L. Longo. Journal of Computer-Aided Materials Design, 12 (2006) 101-110.
[3] P. A. Santa-Cruz, Fibra com Filme Dielétrico Nanoestruturado, BR Patent PI0403088-5 (2004).