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#06-172 Long-term transmission characteristics of CYTOP fiber exposed by gamma radiation

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Polymer optical fibers (POFs) have been attracting substantial attention from research and industry thanks to particular mechanical properties, simple handling, biomedical compatibility and safety. Among POFs, cyclic transparent amorphous fluoropolymer (CYTOP) fiber demonstrates radically low attenuation in the telecom transparency windows of 850 and 1310 nm, thus becoming an efficient solution for short distance communication links. Besides fiber communications, CYTOP fiber has been also intensively studied for various sensing applications: fiber Bragg gratings, Brillouin scattering and intermodal interference are good examples of investigated sensing principles.

A particular topic of research is the use of POFs in radiation environments, including possible solutions for gamma radiation dosimetry. A basic step in this direction is the study of gamma radiation influence on fibers'properties aiming for evaluation of their transmission characteristics degradation. Recently, the gamma-radiation induced attenuation (RIA) in CYTOP fibers was extensively investigated. The RIA was measured in the visible and near-infrared spectral bands, the influence of temperature and relative humidity on irradiated fibers was studied, and the distributed gamma-radiation sensor was proposed. However, evolution of the RIA properties versus time was not considered.

In this work, we focused on the long-term (residual) RIA of the CYTOP fiber. We irradiated 2-m samples of the graded-index CYTOP fiber with core diameter of 50 µm (Chromis Fiberoptics) to 1, 5, 20 and 50 kGy doses, and measured the RIA five months after irradiation. The experimental setup was based on broadband supercontinuum light source Super K Compact, 450-2400 nm (NKT Photonics) and optical spectrum analyzer Yokogawa AQ6374, 350-1750 nm. We utilized cut-back technique and the attenuation spectrum of unirradiated CYTOP fiber, measured in advance. The results demonstrated significant residual RIA in the visible range as well as at wavelengths above 1300 nm. For example, values of 40 dB/m at λ = 600 nm and 68 dB/m at the RIA spike in the vicinity of λ = 1450 nm were measured for the sample irradiated to 50kGy.

To investigate the evolution of the RIA with time, we irradiated two additional fiber samples to 5 and 17.5 kGy doses and continuously measured the RIA up to 80 hours with the measurement started shortly after irradiation. The results demonstrated contrasting RIA time evolutions for visible and near-infrared spectral ranges: partial recovery of transmission properties in the visible range, while in the near-infrared spectral range the RIA increased with time.

Thus, we have found that the post-irradiation time-evolution of the RIA in gamma-irradiated CYTOP fibers strongly depends on the wavelength range. The transmission partly recovers in the visible range, while at wavelengths above 1300 nm the RIA grows and saturates. We conclude that the RIA induced by gamma irradiation in CYTOP fibers persists for a long time, and can be considered as permanent in the NIR.

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