Effect of Photo-darkening on the Response Time of PbSe Quantum-dots Doped Optical Fiber

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We fabricated silica glass optical fiber containing PbSe quantum-dots (QD) of average size 3.2 nm. The response time of the PbSe-QD doped optical fiber was measured to be around 200 ps. However, after exposure to 1064 nm laser emission for 15 minutes, the response time dramatically reduced to around 2.5 ps, which may be due to photo-darkening effect.

Recently, IV-VI semiconductor quantum dots (QDs) of lead chalcogenides such as PbS, PbSe and PbTe have generated interest in the research community due to their applicability for the optical communication devices owing to their properties of narrow band-gap, large nonlinearity, and fast response time [1]. To use the semiconductor QD doped optical fiber for switching applications, response time plays an important role. In the current communication, we experimentally investigated the response time of PbSe QD doped optical fiber.

The MCVD technique was used to fabricate the alumino-germano-silicate optical fiber preform with its core doubly doped with the acid solution containing 5 mg each of Pb and Se. The fiber was drawn with outer diameter of 125 μm, core diameter of 8 μm, and numerical aperture of 0.13. The attenuation spectrum was measured using the cutback method at room temperature and the result is shown in Fig. 1. A broadband absorption with prominent peak at 1117 nm was observed, which was attributed to PbSe particles of 3.2 nm in radius embedded in the core of the fiber. Absorption peak at 1400 nm was due to OH impurity in the fiber.

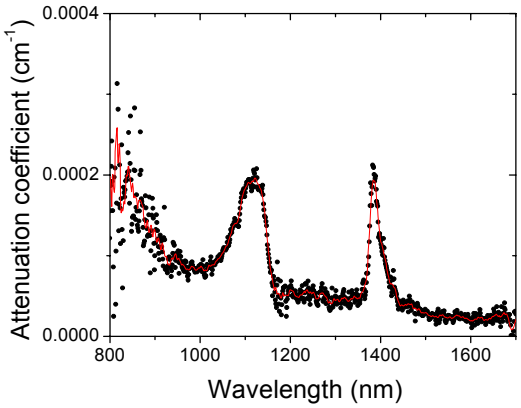

Fig. 1. The Spectral variation of attenuation of the PbSe QDs-doped optical fiber. Continuous line is a curve fit for guide to an eye.

To measure response time of the PbSe QD doped optical fiber, we chose 50 m of the fiber and it was pumped with the pulsed 980 nm laser diode (200 mW). The resulting optical emission was detected with the fast detector and the time variation of signal was recorded using the digital storage oscilloscope (CRO). The resulting decay curve is shown in Fig. 2(a), where the delay time of about 200 ps can be observed. The same fiber was then removed from the response time measurement system and pumped with 1 W power of the 1064 nm continuous wave (CW) fiber laser. The pumping was stopped after 15 minutes and a significant reduction in the transmission was noticed, which can be attributed to the photo-darkening effect [2-4]. Then the fiber was again

replaced to the response time measurement system and recorded decay curve at CRO is shown in Fig. 2(b). Estimated response time for the latter case became about 2.5 ps, which was much faster compared to the first response time measured. This dramatic decrease in the response time is thought to be related the photo-darkening effect, which will be reported somewhere else.

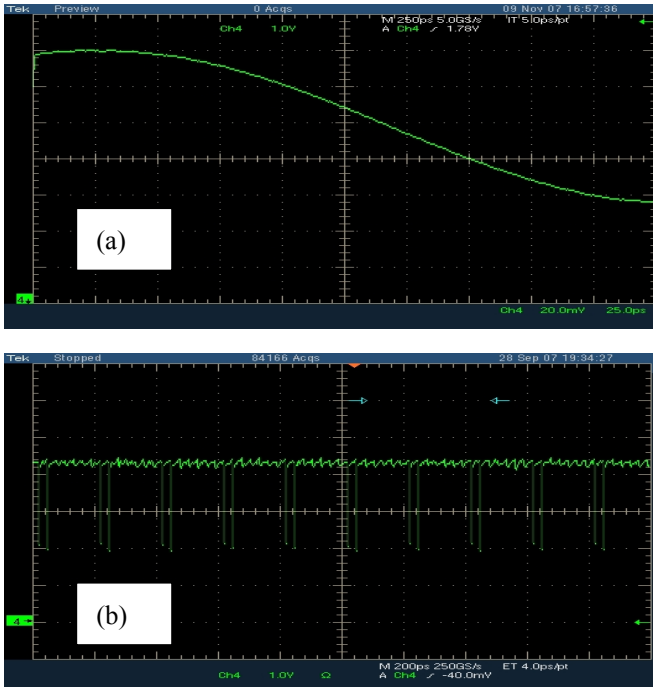

Fig. 2. The response time of the PbSe QDs-doped optical fiber (a) before and (b) after photo-darkening.

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