Random Laser Action on Bacterial Nanocellulose Aerogel Doped with Rhodamine 6G

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The Random Laser (RL) is a specific type of laser, a concept initially proposed by V S Letokhov (1939-2009), which enables laser action to occur within a material that disperses light on multiple occasions (multiple scattering gain medium). In contrast to traditional lasers, which necessitate a cavity to trap light, RL relies on particles within the medium to disperse light and extend its path length. This prolonged interaction between the light and the gain medium results in stimulated emission, thereby creating a laser emission. An energy pump excites the sample containing the gain medium, and the multiple scattering centers facilitate light amplification within this cavity. Additionally, RL exhibits partial coherence, contingent upon the size of the particles utilized as scattering centers, total coherence, and incoherence, with the elimination of speckle noise [1]. The SiO_2-coated bacterial cellulose hydrogel was prepared as previously described by Almeida da Silva et al. and is obtained through a biosynthetic process by bacteria of the genus Komagataeibacter xylinus (considered Gram-negative, strictly aerobic, and non-photosynthetic), which converts glucose, glycerol, and other organic substrates into cellulose in a few days [2]. Three different samples were studied in this work according to their thickness: The samples were prepared with BC1 of approximately 0.6 mm, BC2 = 1.1 mm, and BC3 = 1.7 mm. All samples had the same laser dye concentration. In the experimental procedure, we utilized a Q-switched Nd:YAG laser at a wavelength of 532 nm as a pump, operating at a repetition rate of 20 Hz with a temporal width of 5 ns. For samples BC1, BC2, and BC3, we observed very close energy threshold values, as well as a thinning of the emission band and the FWHM value. These samples thus proved to be useful templates for RL action with low photodegradation. Furthermore, the nanocellulose nanofibers exhibited a similar behavior, demonstrating that they do not change as the thickness increases.

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References

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