AN ANALYSIS OF COUPLING BETWEEN A WHISPERING GALLERY MODE LASER AND THE DOMINANT MODE IN AN OPTICAL FIBER SURROUNDED BY IT

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The problem of coupling a whispering gallery mode (WGM) laser into an optical fiber is considered. The whispering gallery mode laser is generated in a polymer microring formed coaxially on an optical fiber. The focus of this work is to determine factors that influence the coupling between the laser and the fiber around which it is formed.

The coupling mechanisim is analyzed and as the result, there is no coupling between the WGM laser and fundamental mode in the fiber if both fiber and microring are rotationally symmetric. So, disturbing the orthogonality becomes the key issue in obtaining the coupling. Some structures with disturbed symmetry are studied and an elliptical microring on an elliptical fiber is found to be the most simple and practical geometry. Elliptic-cross-section fibers have been shown to preserve polarization and they are important in applications where polarization mode dispersion is a performance limiting effect. Beyond this, we are able to show that modes in an elliptical fiber are not orthogonal to each other across the different material regions, and consequentially we expect coupling of the laser into the fiber.

From the characteristics of Mathieu functions, in terms of which the fields in an elliptical dieletric waveguide are represented, we determine that the coupling between the laser and the dominant mode in the fiber can be controlled by the dimension of the microring, the eccentricity of the elliptical cross section, and the material contrast between fiber and microring.

The most convenient control is found to be the eccentricity of the ellipse. The more eccentric ellipse results in the stronger coupling, and this opens the promise of pumping fiber-optical devices, such as amplifying fiber, from an array of WGM lasers arrayed along the fiber.

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5. The paper has also been submitted to the student paper competition.