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Raman lasing and Fano lineshapes in a packaged fiber-coupled whispering-gallery-mode microresonator

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Abstract:

We report Raman lasing and the optical analog of electromagnetically-induced-transparency (EIT) in a whispering-gallery-mode (WGM) microtoroid resonator embedded in a low refractive index polymer matrix together with a tapered fiber coupler. The microtoroid resonator supports both single mode and multimode Raman lasing operation with low power thresholds. Observations of Fano and EIT-like phenomena in a packaged microresonator will enable high resolution sensors and can be used in networks where a slow light process is needed. These results open the way for portable, robust, and stable WGM microlasers and laser-based sensors for applications in various environments.

Key words:

Microcavities, Optical resonators, Packaging, Raman Lasing, Fano, EIT.

1. Introduction

Whispering gallery mode (WGM) resonators have received increasing interest in many fields of contemporary photonics, such as optical sensing [1-5], nonlinear [6-9] and quantum optics [10,11], lasing [12-16], optomechanics [17-19], and fundamental studies [20-23], owing to their high quality factors and highly confined fields (i.e., micro-scale mode volume). Traditionally, prisms, angle-polished fibers, and tapered fibers have been used for coupling light in and out of WGM microresonators. With advances in fabrication technologies, monolithic fabrication of resonators and their coupling waveguides has also been demonstrated [24]. More recently, there have been reports of coupling free-space light into the resonator by breaking the circular symmetry of WGM resonators via intentionally induced deformations [25,26] or scatterers [27]. Among these various coupling schemes, tapered fibers have been demonstrated to be ideal couplers because of their high coupling efficiency and their ability to achieve critical coupling, where transmission drops to zero [28]. Despite their ideality, there are still issues to be solved to utilize tapered fiber couplers in practical and in-field applications, because (1) achieving and maintaining good coupling requires the use of expensive nanopositioning systems for the resonators to be used, (2) fiber tapers are fragile