

Excitation of whispering gallery modes by two-photon absorption induced by evanescent field

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Abstract – Enhanced whispering gallery modes were excited by two-photon absorption induced by a focused evanescent field. An analysis of the dependence of the spectral and cavity parameters on the near field illumination was done which showed great enhancement with increase in the evanescent component.

I. INTRODUCTION

We have excited whispering gallery modes using two-photon absorption by an evanescent field. Evanescent fields generated by total internal reflection [1] or by a guided wave [2] have been popularly employed to efficiently transfer optical energy to resonators.

II. EXCITATION OF MDR

The focused evanescent field was generated using a ring beam which is centrally obstructed such that it cuts off all the rays below the critical angle for the cover glass - air interface[3]. Such an annular beam was tightly focused using a high numerical aperture objective (NA = 1.65) and made to undergo total internal reflection at the interface, generating an evanescent field. An ultra short pulsed laser (Spectraphysics Tsunami) was used so that the high local intensity of the focused beam and the temporal confinement of the pulsed laser facilitated two-photon absorption[4].

Fluorescent microspheres from Polysciences Inc. with an excitation peak of 486nm was used so as to ensure efficient two-photon absorption while using the Ti-Sapphire laser at a wavelength of 800nm. The quadratic dependence of the MDR peak intensity on the input power was demonstrated.

The inner diameter of the annulus of the beam was gradually increased from zero to a value very near to the entrance aperture of the objective and whispering gallery modes were excited for each case, so that the relative contribution of evanescent field to the cavity performance parameters could be

analysed. The MDR spectra were recorded and the dependence of the spectral and cavity parameters such as the visibility of the MDR spectra, the Quality factor and the degree of polarization of the peaks on the evanescent field component were analysed in detail. It was found that the visibility, Quality factor and degree of polarization of the MDR peaks improved significantly with the evanescent excitation.

III. CONCLUSION

To summarize, whispering gallery modes were excited by two-photon absorption induced by a focused evanescent field. The morphology dependent resonance spectra showed enhanced spectral and cavity performance with the near field excitation which demonstrated the high efficiency of evanescent coupling to microcavities relative to radiative coupling.

Keywords: evanescent field, two-photon absorption, whispering gallery modes (WGM), morphology dependent resonance (MDR)

References:

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