FIBER RING LASER FOR SENSING USING A MICROSPHERICAL RESONATOR

D. Farnesi[1,2,3], S. Berneschi[3], F. Cosi[3], C. Trono[3], G. C. Righini[1,3], S.Soria[3], G. Nunzi Conti[3]

[1]Centro Studi e Ricerche "E. Fermi", Piazza del Viminale 2, 00184 Rome, Italy
[2]Dip. di Chimica Organica e Industriale, Parco Area delle Scienze 17/A, 43100 Parma
[3]CNR-IFAC, Institute of Applied Physics "Nello Carrara", Via Madonna del Piano 10, 50019 Sesto Fiorentino (FI) Italy

Certain applications in medicine, biodefense, drug discovery, and environmental monitoring depend on the ability to detect low concentration pathogens and nanoscale viruses. Whispering gallery mode (WGM) resonators have been studied extensively in recent years for applications in ultrasensitive sensing. Various type of resonator geometries have been considered, being the microsphere the most studied one. The typical approach consists of the detection of the passive cavity resonance shift when a change in the refractive indices at of the resonator and/or the environment immediately surrounding the microsphere surface takes place. We demonstrate that by using a microsphere cavity to stabilize an erbium-doped-fiber-based ring laser we obtained the same shift for the laser line as for the cavity resonance [1]. This sensing approach not only includes simpler and cheaper equipment but may also effectively increase the limit of detection because of the narrower laser linewidth compared with the 'passive' resonance linewidth.
We induced the resonance shift through thermal effect by placing the microsphere in a homemade thermostatic cell. The sensitivity of the proposed sensor device is about 1.8 GHz/°K. It is important to note that while the temperature-induced resonance shift is the result of a bulk effect inside the silica sphere, the proposed sensing mechanism does not depend on how the shift is produced. Indeed this effect takes place whenever a refractive index change occurs in a region probed by the WGM, including in its evanescent tail.

[1] G. Nunzi Conti, S. Berneschi, A. Barucci, F. Cosi, S. Soria, C. Trono, Opt. Lett. 37 (2012) 2697-2699