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**Abstract****Title: *Optical transport phenomena in coupled spherical cavities***

Due to a unique combination of properties mesoscopic systems of coupled spherical cavities can be used for developing technology of integration of cavities in three spatial dimensions (3D) in chip-scale structures for a variety of optoelectronics applications. These properties include record quality (Q) factors of whispering gallery modes (WGMs) in spheres, possibility to achieve supermonodisperse properties of these cavities, and the possibility to control their positions and separations.

In this work we study mesoscopic systems of coupled spherical cavities with $\sim 1-3\%$ size disorder resulting in a random energy detuning between their WGMs. The optical transport in such systems can be achieved due to two novel mechanisms: (i) formation of periodic photonic nanojets [1] theoretically predicted in [2] and (ii) evanescent coupling between quasi-WGMs [3,4]. We observed extremely small attenuation $< 0.1\text{dB/sphere}$ for nanojet-induced modes in chains of cavities. The efficiency of evanescent coupling between quasi-WGMs is found to be less tolerant to the effects of disorder resulting in attenuation $\sim 3\text{dB/sphere}$.

We suggest new interpretation of the optical transport properties of 3D lattices of cavities based on analogy with percolation theory. The sites of the lattice (spheres) are connected with bonds which are present with probability p depending on the detuning between WGMs. For small p only a few bonds are present, thus only small clusters of sites connected by bonds can form, but at critical probability p_c , called the percolation threshold, a percolating cluster of sites connected by bonds appears. Experimentally, in transmission spectra of such 3D structures we observed spectral signatures of existence of well connected clusters of spheres. We argue that by selecting more uniform spheres one should be able to achieve optical percolation threshold for WGM transport.

References

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Biography

DR. ASTRATOV is an associate professor in the Department of Physics and Optical Science at the University of North Carolina-Charlotte. He received his M.S. from the St. Petersburg State University, Russia, in 1981, and received his Ph.D. degree from the A.F. Ioffe Physical-Technical Institute, St. Petersburg, in 1986. In 1993-1997 he headed a research group at the Ioffe Institute where he pioneered studies of synthetic opals as new three-dimensional photonic crystal structures, the work which directly resulted in a quest for high contrast opals with a complete photonic band gap. In 1996 he was awarded a grant of Royal Society that enabled his visit to the University of Sheffield, U.K. In 1997-2001 he worked as a postdoctoral scholar at the University of Sheffield where he developed novel surface coupling techniques for studying photonic crystal waveguides, and was engaged in the studies of semiconductor microcavities. He has been an assistant professor from 2002 to 2007 in the Department of Physics and Optical Science at the University of North Carolina-Charlotte, where he is now an associate professor. His current research aims at exploring individual ultra high- Q resonances available in a variety of semiconductor and dielectric structures for building more complicated coupled cavity systems or mesoscopic crystal structures with useful optoelectronic functionality. He is a topical editor for the journal Optics Express since 2005, and he has served as a technical committee member for CLEO/QELS 2006-07, Special session on Microresonators and Photonic Molecules at ICTON 07, and OECC/ ACOFT 08. He has been a member of the international DFG panel on photonic crystals in Germany. He is a recipient of a number of awards including Senior Visiting EPSRC Fellow Award in the UK, Award of the Exchange Program adopted between Royal Society and Russian Academy of Sciences, and the Award in the Annual Competition from A.F. Ioffe Physical-Technical Institute. He is a member of OSA and SPIE.