"APPLICATIONS OF MICRORESONATORS: FROM PHOTODETECTORS TO BIOLOGICAL SENSING AND IMAGING"

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Optical resonance is one of the key properties of light enabling important devices such as interference filters and lasers. We present application of micro-resonators to resonant cavity enhanced (RCE) photodetectors and biological sensing and imaging techniques.

The importance of optical resonance has long been recognized and the interference due to multiple reflections had in fact been analyzed theoretically by George Airy nearly two centuries ago. Optical resonator has become a household name since Fabry and Perot. Over the past decade a new family of optoelectronic devices has emerged whose performance is enhanced by placing the active device structure inside a Fabry-Perot resonant microcavity. In such structures, the device functions largely as before, but is subject to the effects of the cavity, mainly wavelength selectivity and a large enhancement of the resonant optical field. The increased optical field allows photodetectors to be made thinner and therefore faster, while simultaneously increasing the quantum efficiency at the resonant wavelengths. We have demonstrated a variety of RCE photodetectors in compound semiconductors and Si, operating at optical communication wavelengths ranging from 850nm to 1550nm.

We have recently developed techniques in biological sensing and imaging using optical resonance. The Resonant Cavity Imaging Biosensor detects binding on a microarray surface and promises high-sensitivity as well as simultaneous imaging of very large arrays. A novel application of resonance to fluorescence microscopy promises nanometer resolution in biological imaging. Over the past 20 years fluorescence microscopy has developed into a standard tool in biological sciences. We have developed a new technique – spectral self-interference fluorescent microscopy – that transforms the variation in emission intensity for different path lengths used in fluorescence interferometry to a variation in the intensity for different wavelengths in emission, encoding the high-resolution information in the emission spectrum. Using monolayers of proteins as well as single and double stranded DNA we have demonstrated sub-nanometer axial height determination for thin layers of fluorophores.