세미나 안내

Optofluidics toward lab-on-a-chip biosensors

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Novel optofluidic ring resonator (OFRR) lasers resolving problems of existing lasers have been demonstrated and DNA melting analysis taking advantages of the OFRR laser is suggested. The OFRR laser fabricated on a polymer chip utilizes two optically coupled ring resonators in different sizes in order to address an intrinsic multi-mode emission of the ring resonator laser. A single-mode emission is obtained by Vernier effect and the wavelength is tunable by modifying the refractive index of the gain medium. A quasi-droplet OFRR laser is developed based on a micro-bubble filled with liquid gain medium. Due to the sub-micron wall thickness, the micro-bubble mimics a droplet in air that has 3-dimensional optical confinement, extremely high Q-factor and versatility of handling liquids of different refractive index. The laser using Rhodamine 6G in methanol has low lasing thresholds and dye concentration. Furthermore, it enables repetitive interrogation and easy directional laser emission out-coupling without evaporation or size/shape variations. Microdroplets in carrier fluid are delivered to the capillary OFRR downstream and laser emission is obtained. The laser can conveniently be coupled into an optical fiber and lasing threshold 6 times lower than the state-of-art is achieved. An efficient FRET lasing is also demonstrated making the OFRR droplet laser an attractive platform of bio/chemical sensing with small sample volume.

A highly specific intracavity DNA melting analysis scheme utilizing the optofluidic laser is proposed. The laser optically amplifies the small yet intrinsic thermal dynamic difference between the target and the single-base-mismatched DNA, resulting in a differential signal that is orders of magnitude greater than with fluorescence-based methods. In particular, the existence of a phase transition between the stimulated laser emission and fluorescence enables accurate determination of the DNA transition temperature difference. Furthermore, the high differential signal in the intracavity detection allows for scanning of the laser excitation at a fixed temperature to distinguish two DNA sequences, which provides another means for rapid DNA analysis. The intracavity DNA detection leads to novel optofluidic devices that enable rapid and simple analysis of DNAs and shifts the concept of DNA analysis from analogue to digital.

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