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Biochemical Sensor Based on Single-Microsphere-Coupled Mach-Zehnder Interferometer

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A cost-effective sensor based on single-microsphere-coupled Mach-Zehnder interference is theoretically investigated, which is related to the asymmetric Fano resonance line shape. Fano resonance results from interference between a resonance pathway associated with a high-Q microsphere and a coherent background pathway by introducing an extra phase shift. The sensor can be realized when the refractive index of a fiber taper changes in the nonresonance arm and that of a high-Q microsphere resonator remains constant. Besides, the gap distance between the fiber taper and microsphere can be easily tuned to achieve high sensitivity in the case of overcoupling. The spectral responses of this device in glucose solutions of different concentrations are theoretically calculated. It can produce a sharp asymmetric Fano resonance line shape related to the slope between zero and unity transmission. The gradual change in Fano line shape can be observed owing to the solution concentration change. The variations in relative intensity are approximately linearly related to low and high solution concentrations at special wavelengths. This structure can be that of the promising highly sensitive biochemical sensor owing to the high quality factor and tunable slope over the resonant frequency range.

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