Sapphire Microspheres: Possible Applications to Biosensing

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Circular cavities [1] such as microspheres [2], microdisks [3], and microtoroids [4] with high quality factor whispering gallery modes (WGMs) continue to open up new perspectives in sensing [5-8]. Here, we report an optical setup for a DNA optical biosensor based on sapphire microsphere. The transmitted and elastic scattering intensity at 1510 nm were analyzed from a sapphire microsphere on an optical fiber half coupler. The 0.43 nm angular mode spacing of the WGMs correlated well with the optical size of the sapphire microsphere. The spectral linewidths of the WGMs were on the order of 0.01 nm, which corresponded to quality factors on the order of 10^4. Afterwards, the sapphire microsphere was modified with DNA and an optical biosensor is demonstrated using an insulating implant material such as sapphire. A probe DNA, consisting of a 36-mer fragment was covalently immobilized on sapphire microsphere and hybridized with a 29-mer target DNA. WGMs were monitored prior to the sapphire's functionalization with DNA and after the sapphire was functionalized with single stranded DNA (ssDNA) and double stranded DNA (dsDNA).

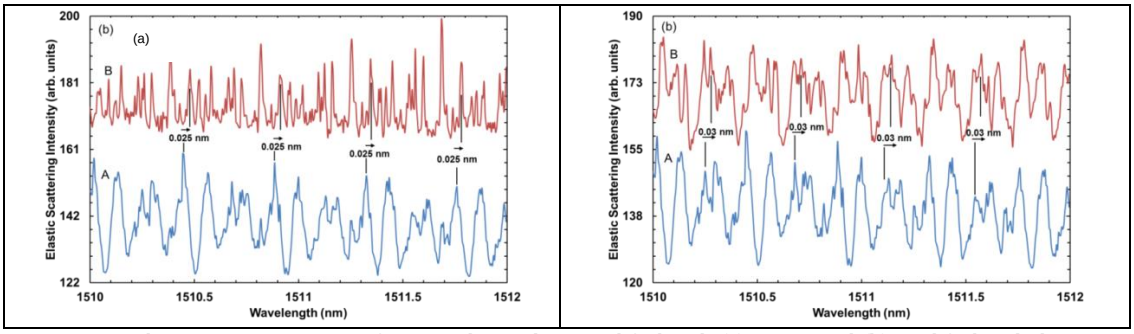

Fig. 1 90° elastic scattering spectra from sapphire sphere modified with (a) ssDNA and (b) modified with dsDNA showing the corresponding shift for (A) non-modified sphere and (B) sphere modified with DNA.

The shift in WGMs due to the surface modification with DNA was measured and correlated well with the estimated add-on DNA layer. It was shown that ssDNA are more uniformly oriented on the sapphire surface than the dsDNA. In addition, it was shown that the functionalization of the sapphire microsphere's surface with DNA does not affect the high quality factor ($Q \approx 10^4$) of the WGMs. All in all, we have taken the first step towards utilizing a structural, electrically insulating implant material as an optical microcavity based biosensor platform paving the way for future in vivo biosensing devices [9, 10].

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