Simulation of Bio-medical Waveguide in Mechanical and Optical fields

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Introduction: There is a possibility of leakage after surgery called anastomosis leakage which can lead to severe complications or even death. This paper presents a freestanding waveguide to detect anastomosis leakage after colon surgery in early stage [1]. The schematic of the freestanding waveguide is shown in Figure 1.

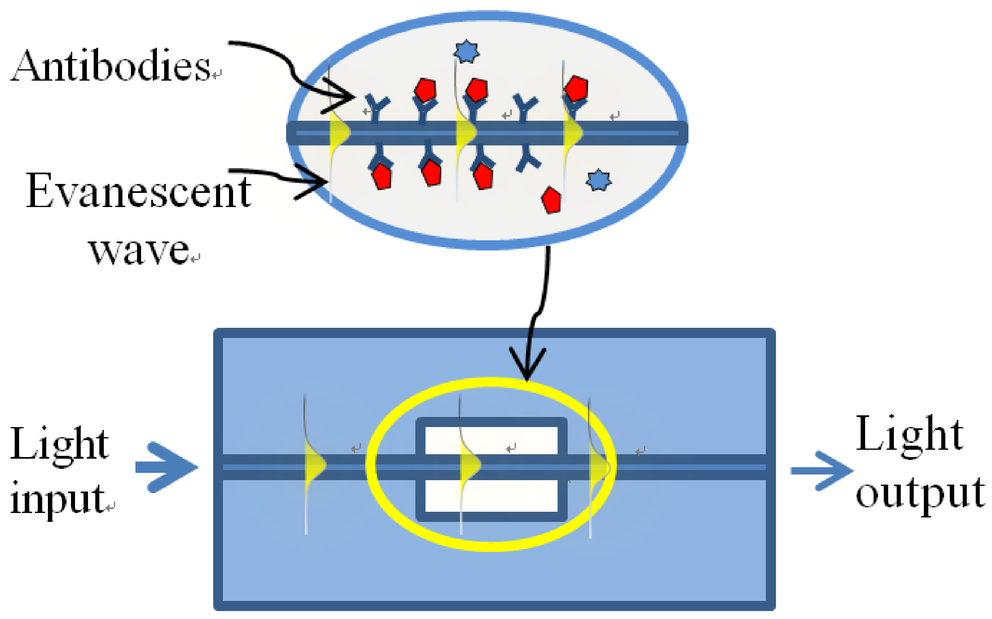

Figure 1. The schematic of the freestanding waveguide

Design and simulation: The freestanding part is a thin membrane consisting of TiO_2 rib and SiN ridge. Figure 2 shows the cross section of the freestanding waveguide. Both surfaces are functionalised with specific antibodies to catch E-coli in the drain fluid. When light propagates through the freestanding region, there will be evanescent wave on both surface (Figure 3) which will interact with the captured E-coli. The freestanding part is considered optically and mechanically to be sensitive and mechanically stable [2-3].

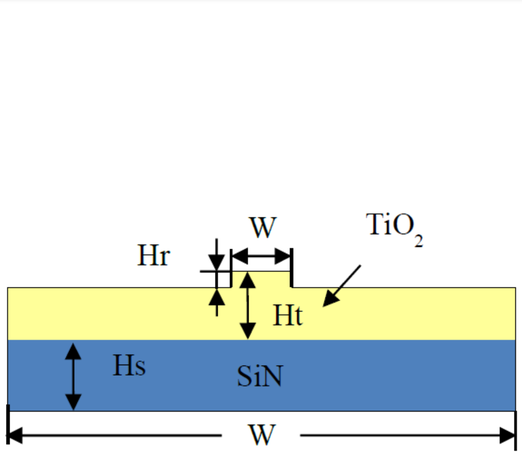

Figure 2. Cross section of waveguide

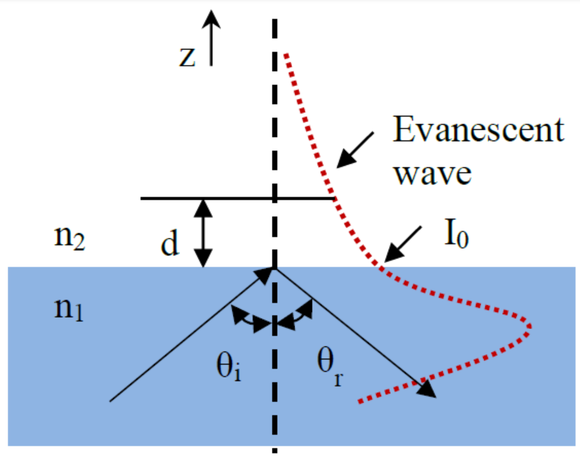

Figure 3. The evanescent wave profile

Results: Figure 4 shows the optical distribution on the cross section. Figure 5 shows the inner stress induced deformation. The maximum deformation is 0.21μm whose influence on optical propagation can be neglected.

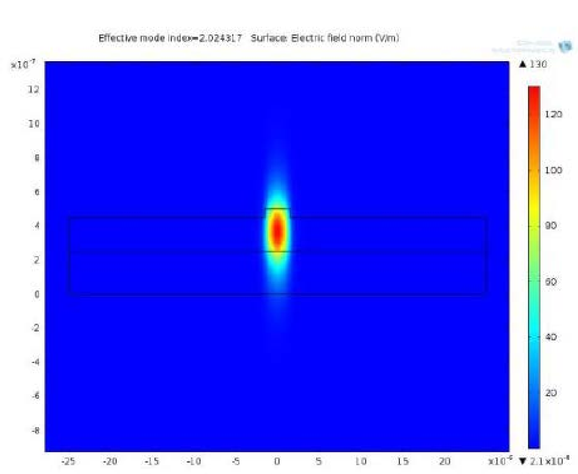

Figure 4. Optical distribution on cross section

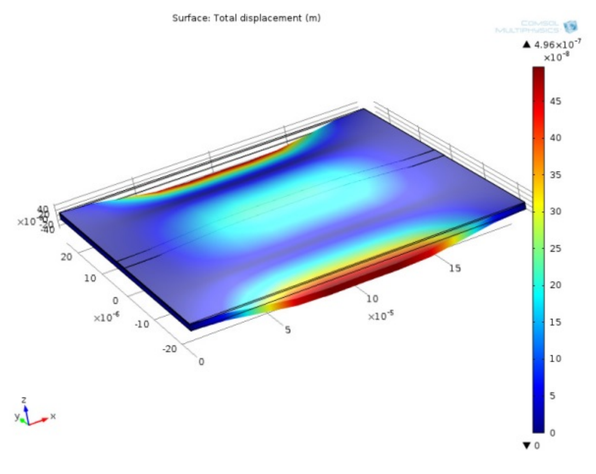

Figure 5. Deformation induced by inner stress

Conclusions: The feasibility of the freestanding waveguide for biomedical application is demonstrated. Evanescent wave can be used for the purpose of detecting bacteria on the waveguide surface. Considering sensitivity and mechanical property, the final parameters are Hs=200nm, Hr=10nm, Ht=50nm and Wt=3μm.

References:

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