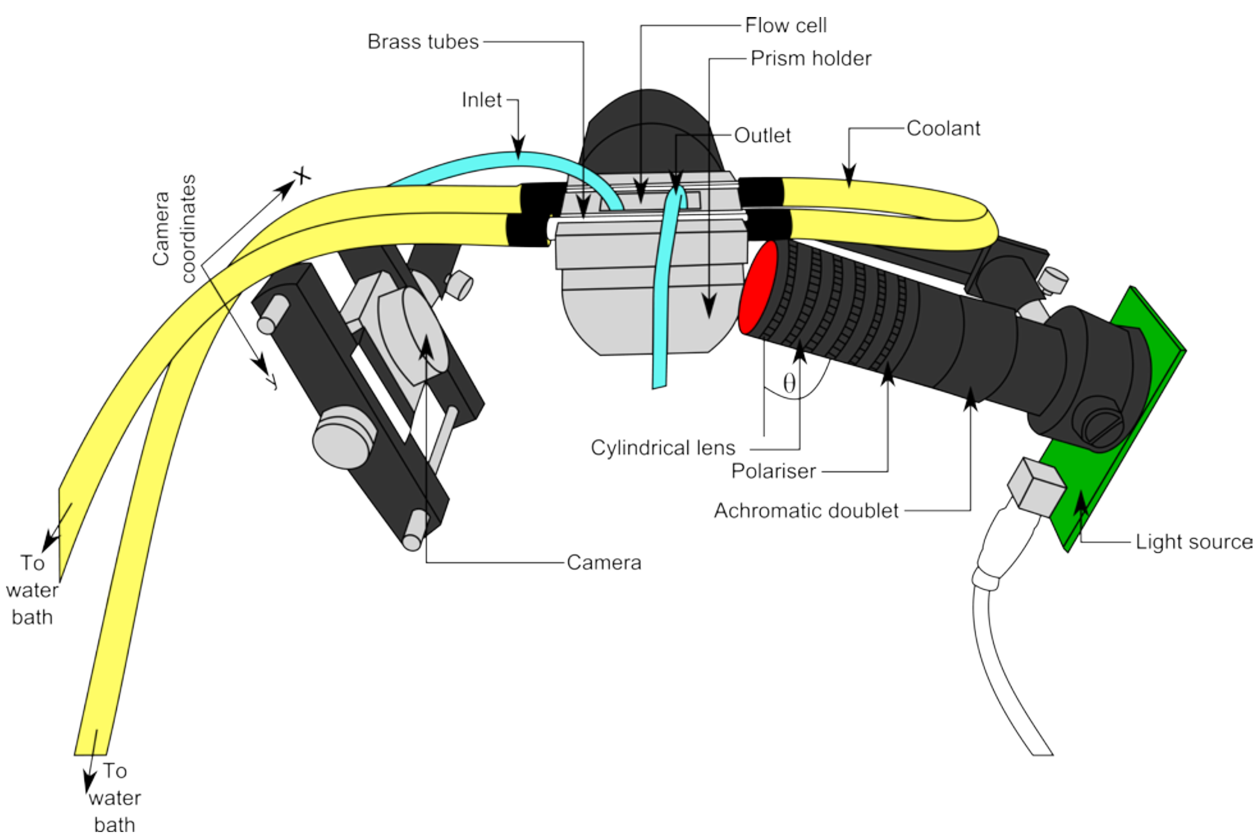

Figure S1: Schematic of the set-up used to perform sensing using the RM device (where θ is the angle of incidence)

Results and discussion

Design of the RM device

The RM device developed in this work consisted of a polystyrene waveguide and silica sol-gel spacer layers on a glass substrate. Initial modelling was performed by assuming that water was placed on the top of the waveguide layer. For the purpose of modelling, the refractive index of the water, polystyrene, silica sol-gel and glass was assumed to be 1.333, 1.585, 1.42 and 1.517 respectively. The thickness of the silica sol-gel and polystyrene layer was assumed to be 0.5 µm and 1 µm respectively. The glass and water layers were assumed to be semi-infinite. The profile of the optical mode travelling in the RM structure for TE- and TM-polarised light is shown in Figure S2 (a). A comparison of phase change versus the angle of incidence of the light source for TE- and TM-components of light coupled out of the RM is shown in Figure S2 (b).

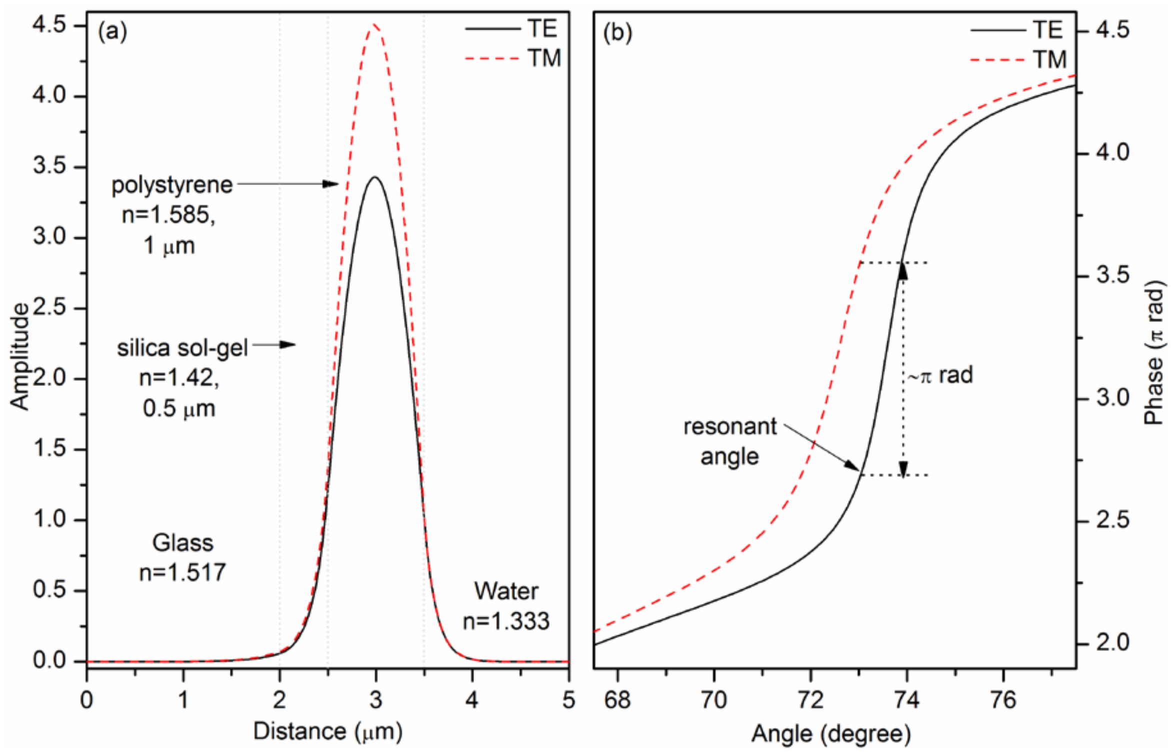

Figure S2: (a) Profile of the optical mode in the RM and (b) plot of the phase of reflected light as a function of the angle of incidence of TE- and TM-polarised light source

As the phase difference between TE- and TM-components changes with the angle of incidence, the ellipticity of light coupled out of the RM device also changes. For example, at an angle of incidence of ~70°, the phase difference between the TE- and TM-components is π/2. Hence, light coupled out of the RM device at an angle of incidence of ~70° would be circularly polarised. Similarly, at the resonance angle (in this case, ~73°), the phase difference between TE- and TM-components of light is ~π (or 180°). This implies that light out coupled from the RM device at resonance angle is linearly polarised, but its polarisation axis is orthogonal to the input. As a result, a peak in reflectivity is observed at the resonance angle when an output cross polariser is used.

The reflectivity curve of a RM device with water placed on the top of polystyrene waveguide for TE-polarised light is shown in Figure S3 (a).

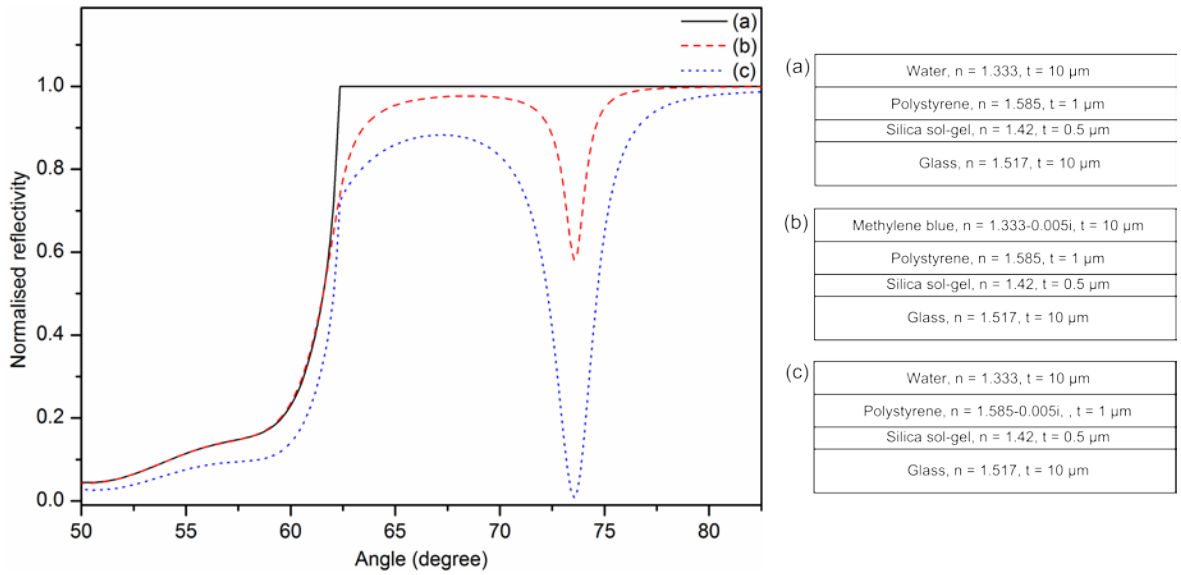

Figure S3: Reflectivity curves of RM devices obtained using dip method (where insets show the scenarios modelled and n and t are the refractive index and thickness of a layer respectively)

Under this scenario, no dip (or peak) in reflectivity is observed at resonance angle because all of the light is reflected back. If, however, an absorbing species is placed on top of the waveguide, the evanescent field of the optical mode travelling in the waveguide can interact with the species and hence a dip in reflectivity is observed at the resonance angle (as shown in trace (b) in Figure S3). In addition, the depth of the dip is proportional to the concentration of the absorbing species present on the top of the waveguide, although this relationship becomes non-linear at higher concentrations. Similarly, as shown in trace (c) in Figure S3, optical losses can be introduced by adding a dye to the waveguide layer. In this case, the optical mode travelling in the waveguide will interact with the dye, thereby resulting in a dip at the resonance angle.

3.2 Preliminary experiments

The effect of the concentration and spin speed of polystyrene solution on the output curve of the RM is illustrated in Figure S4 (a) and (b) respectively.

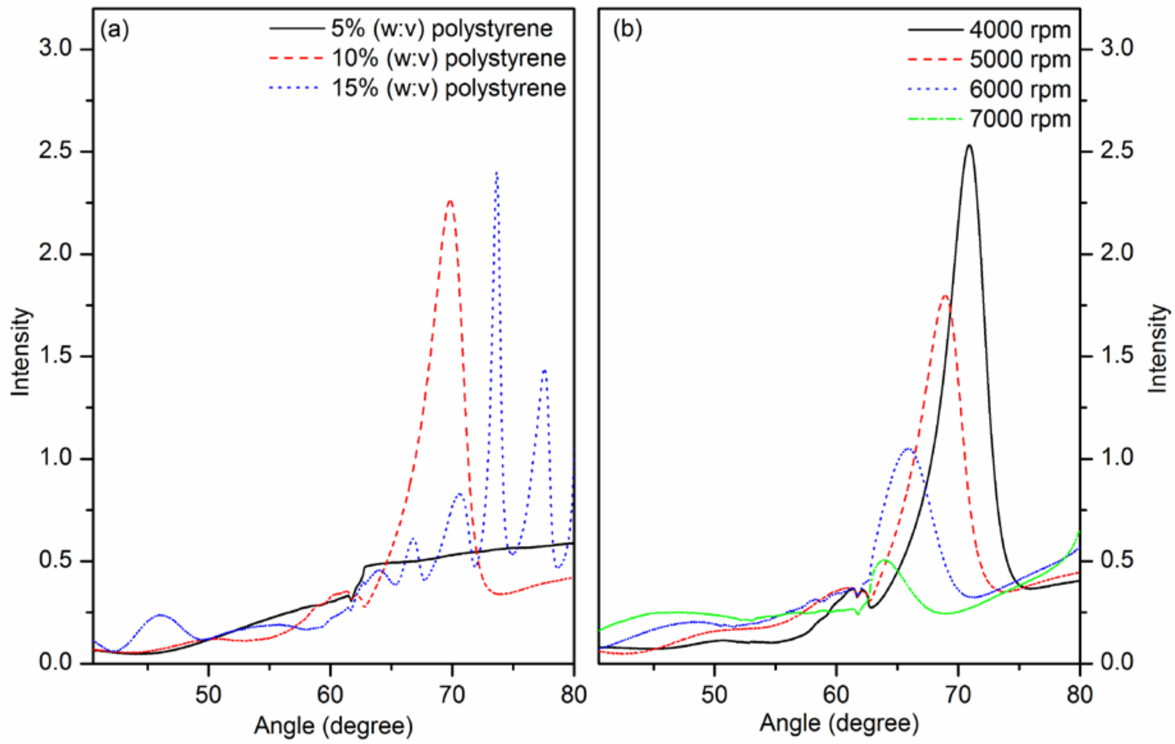

Figure S4: Reflectivity curves of the RM devices fabricated using different (a) concentrations of polystyrene solutions at 4000 rpm and (b) spin speeds of 10% (w:v) polystyrene solution

No peak in reflectivity was observed for the RM device consisting of a waveguide layer made of 5% (w:v) polystyrene solution. This suggested that the waveguide layer made of 5% (w:v) polystyrene solution was incapable of supporting an optical mode and hence too thin. In contrast, multiple peaks were observed in the reflectivity curve of the device consisting of a waveguide made of 20% (w:v) polystyrene solution. This implies that the use of 20% (w:v) polystyrene solution resulted in a waveguide layer capable of supporting multiple modes. As a waveguide layer made of 10% (w:v) polystyrene solution resulted in a single peak, this concentration was chosen to fabricate the rest of the RM devices. Figure S4 (b) shows that as 10% (w:v) polystyrene solution was deposited using higher spin speeds, the resonance angle and intensity of the reflectivity peak decreases. This is because as the spin speed increases, the thickness of polystyrene waveguide layer reduces and its ability to support an optical mode is compromised. Thus, a RM device consisting of a waveguide layer deposited using 10% (w: v) polystyrene solution at a spin speed of 4000 rpm was selected to perform absorption spectroscopy experiments.

Different concentrations of solvent blue 59 were then added to 10% (w:v) polystyrene solution, following which it was spin coated on the top of silica sol-gel/glass structure to obtain dye-doped RM devices. The devices were probed using the dip method and the reflectivity curves are shown in Figure S5 (a). It is clear from Figure S5 (a) that RM devices consisting of a waveguide layer doped with 2 mM and 5 mM solvent blue 59 have higher Q factor than the remaining devices. Figure S5 (a) also shows that the full width at half maximum of the dip of the RM with 2 mM dye-doped polystyrene waveguide was smaller than the device with 5 mM dye-doped polystyrene waveguide (1.29° versus 2.35°). When the devices were, however, probed using the RCLED and camera the dip of the former was noisier in comparison to the latter (see Figure S5 (b)). Thus, the RM device consisting of a waveguide layer made of 10% (w:v) polystyrene solution and doped with 5 mM solvent blue 59 was used to study antibody-antigen interactions.

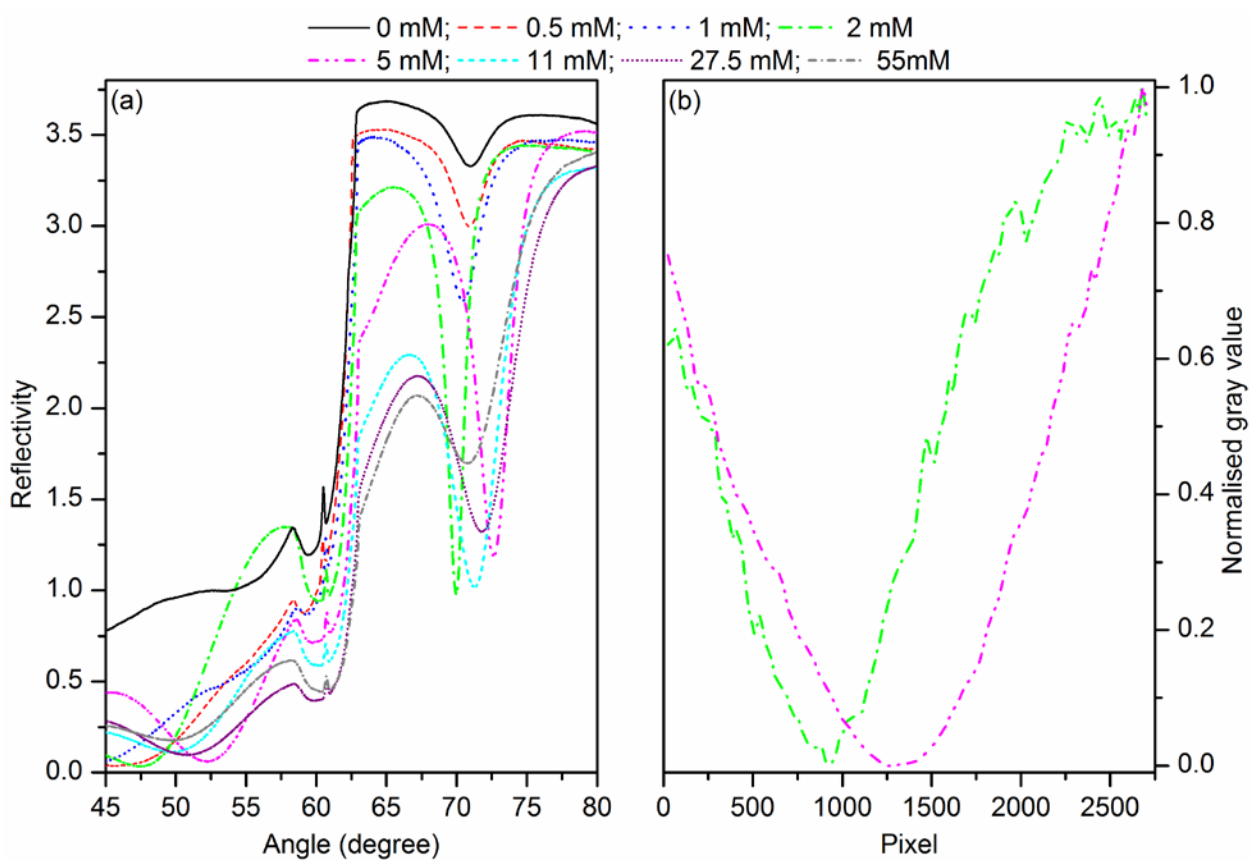

Figure S5: Effect of the concentration of solvent blue 59 in the polystyrene waveguide on the reflectivity curve of the RM device obtained via the dip method using (a) laser and photodiode, and (b) RCLED and camera