Supplementary Information (ESI) for Chemical Communications
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Electronic Supplementary Information (ESI)

Solution immersed silicon (SIS) based biosensors: a new approach in biosensing

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Abstract: This supporting information contains 3 pages covering the details of the simulation, regents, RAE, and the SIS sensor chip production.

Solution Immersed Silicon (SIS) sensor response simulation:

The SIS sensor response was simulated by assuming the Si (100) wafer with SiO_2 of varying thickness immersed in the deionized (DI) water and ellipsometric parameters (ψ, Δ) were calculated under the non-reflecting condition (NRC). The simulation was done by multilayer calculation by using Fresnel equations. Three layered optical model (ambient (DI water) / SiO_2 / Si) was used as shown in Fig. S1. The optical constants at the wavelength (λ) of 655 nm used in multilayer calculation were listed in the table I.

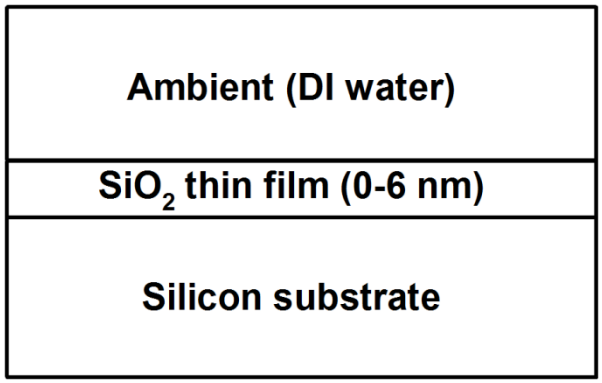

Fig. S1 Optical model used for simulation of the SIS sensor response.

Table S1. The optical constants (at λ = 655 nm) used in the SIS sensor response simulation.

Material	**Refractive index (*n*)**	**Extinction coefficient (*k*)**
DI water	1.3320	0.0000
SiO_2	1.4564	0.0000
Si	3.8391	0.0182

*taken from the Ref. S1.

We used the WVASE software from J. A. Woollam Co. for the simulation. The ψ, Δ spectra with angle of incidence were calculated for increasing thickness of SiO2 from 0 to 6 nm on the Si substrate around the non-reflecting condition (NRC) (Fig. 1a). At the NRC, ψ shows highest sensitivity while Δ is constant. Effect of change of *n* on the SIS sensor response was simulated by varying *n* from 1.332 to 1.333 which equivalent to 1000 RIU. The SIS sensor response is almost constant with respect to the change in *n*.

Experimental details:

Materials:

Human Immunoglobin G (IgG), N-hydroxysuccinimide (NHS), 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide (EDC), 1-ethanolamine, phosphate buffer solution (PBS), hydrofluoric acid, trifluroacetic acid, NH_4OH, and dextran were purchased from the Sigma. The Cyclic peptides were obtained from the Peptron, Daejeon, Korea. H-terminated *P*-type silicon wafer coated with 1-alkene was prepared in the National Nano-Fab Center, Korea.

Instrumentation:

The experimental setup was home-made.

- **Rotating analyzer ellipsometer (RAE):**

Optical elements in the RAE are arranged as source – fix polarizer – sample – rotating analyzer – detector and beam conditioning optics are added in a beam path whenever necessary (Fig. 2a). The source was 25 mW laser with 655 nm wavelength and the detector was a silicon photodiode. The data points were measured in synchronous with the rotating analyzer, details are given in the Ref. S2.

- **SIS sensor chip production:**

The SIS sensor chip production process flow is illustrated in the Fig. S2. *P*-type silicon wafer (100) was treated with hydrofluroric acid to remove native SiO_2, which gives the H-terminated Si (H-Si) surface. The H-Si surface was coated with self assembled monolayer (SAM) of the 1-alkenes (SAM1). The SAM1 is highly stable in the air due to presence of tert-butoxycarbamate (TBOC) group at the tail of polymer chains, which prevent further oxidation and sensor chips can be stor5ed for months. The Si wafer with SAM1 was cut in the pieces of 1.5 × 1.5 cm. The TBOC surface layer was removed by dipping a sensor chip in the trifluroacetic acid and NH4OH respectively, this reaction exposes the amine groups to the surface so that biomolecules can attach to the sensor surface through amine coupling. The dextran SAM (SAM2) was grown on the SAM1 by incubating it in the dextran solution in PBS for 12 h, which facilitates controllable large binding sites results in high sensor throughput. The SIS sensor chip

with SAM2 can be used within 2-3 weeks. All these processing steps were done outside the sensor cell.

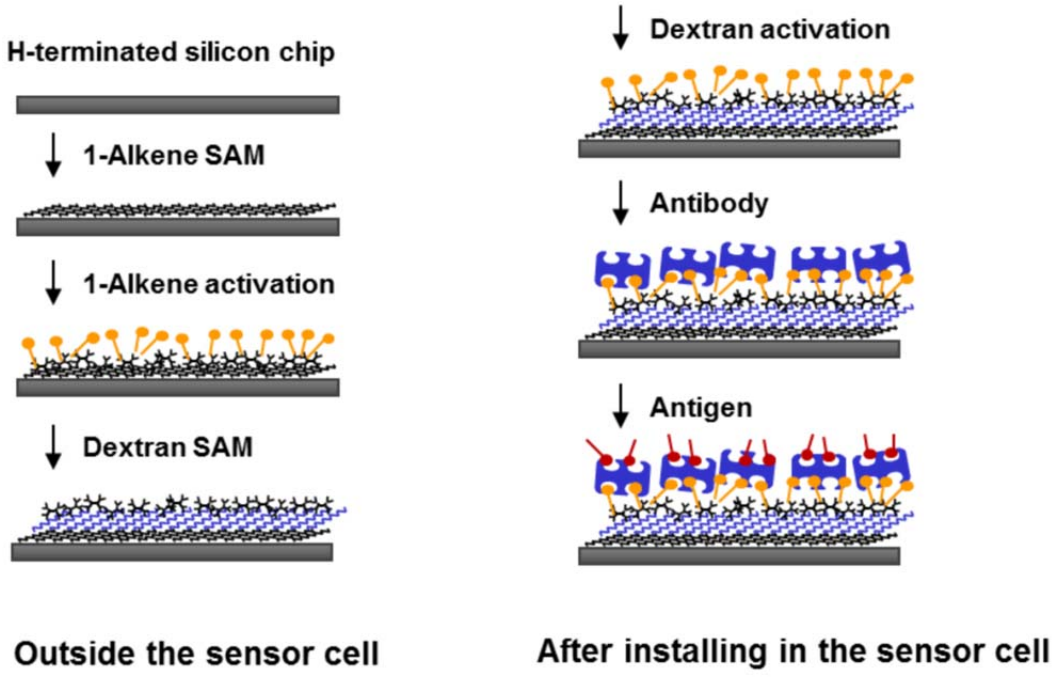

Fig. S2 Processing steps in the production of SIS sensor chips.

The sensor chip was installed in the sensor cell for further processing. The SAM2 surface was activated by flowing 1:1 mixture solution of EDC and NHS and other non-specific binding sited were deactivated by flowing 1 M ethanolamine (pH 8.5) over the sensor surface. Now SIS sensors are ready to measure biomolecules. Antibody and antigen of specific concentrations were flown over the sensor surface and respective biomolecular interactions were measured through thickness change.

References:

S1. M. Daimon and A. Masumura, *Appl. Opt.*, 2007, **46**, 3811–3820.

S2. D. E. Aspnes, *J. Opt. Soc. Am.*, 1974, **64**, 639–646.