Supporting Information

for

Interferometric Optical Sensors Based on Porous Silicon Grafted with Styrenic Moieties for Highly Enhanced VOC Detection

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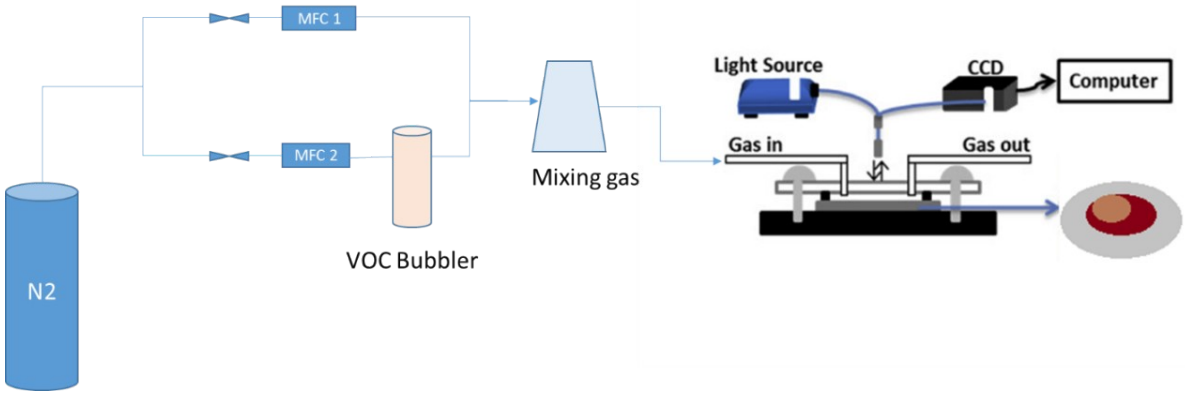
S1. Instrumental analysis

Reflectance spectra were acquired using a CCD spectrometer (Ocean Optics USB-4000) fitted to a bifurcated fiber optic cable as described in Figure S1. One arm of the fiber cable was connected to the spectrometer, while the other arm was connected to a tungsten light source (Ocean Optics LS-1). The distal end of the combined fiber was attached to a microscope objective lens to allow acquisition of 180° reflectance spectra from the sample surface, with a spot size of approximately 1–2 mm^2. The porosity of pSi chips was characterized using the spectroscopic liquid infiltration method (SLIM). Fourier-transform infrared (FTIR) spectra were obtained using a Nicolet 6700 spectrometer (Thermo Scientific) equipped with an attenuated total reflectance (ATR) attachment. The ATR-FTIR spectral resolution was 4 cm^{-1} and 128 scans were averaged per spectrum. Water contact angle measurements (Theta Optical Tensiometer, KSV, Finland) on the pSi chips were performed according to standard procedure. Plan-view and cross-sectional scanning electron microscope (SEM) were obtained using a field emission instrument (FEI XL30) operating at an accelerating voltage of 15 kV. Energy dispersive X-ray (EDX) spectroscopy was performed on cross-sectional samples using an accelerating voltage of 20 kV and a spot size of 4 μm.

S2. RIFTS method

Reflective interferometric Fourier transform spectroscopy (RIFTS) was used to optically monitor the diffusion-controlled adsorption of analytes in the pSi chip. The focal point of RIFTS was approximately 1 mm in diameter, and this spot was positioned at the center of the pSi chip. The interference spectrum is originated from thin film Fabry−Pérot interference of light reflected from the air/porous Si and porous Si/crystalline Si interfaces. The interference spectrum is de-convoluted by applying a fast Fourier transform (FFT) to the reflectance vs frequency spectrum, which yields the value of the effective optical thickness, 2nL, where n is the average refractive index of the porous layer and L is the thickness of the porous film. The quantity 2nL is expected to increase with increasing the adsorbed amounts of analyte in the porous layer.



Scheme S1. Schematic set up of VOCs detection system.

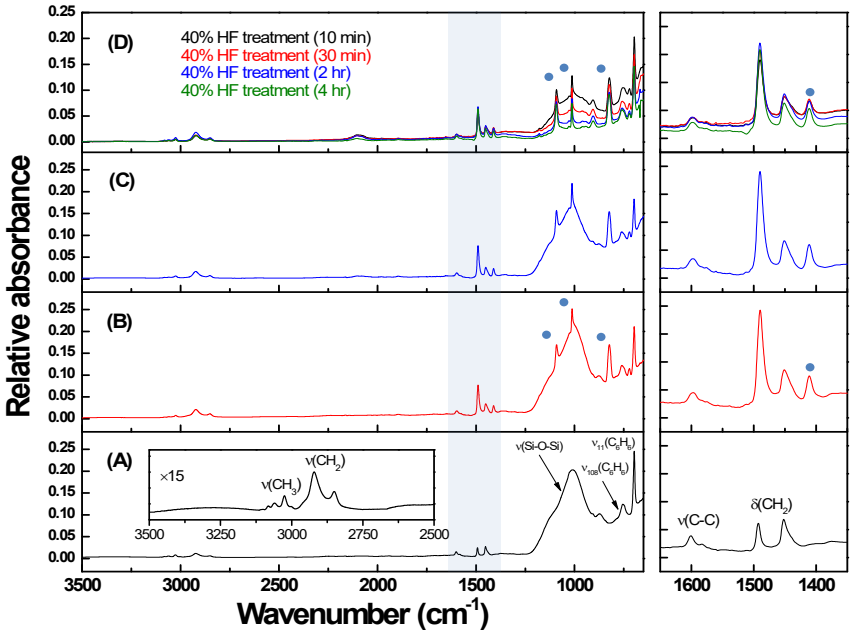


Fig. S1. FTIR spectra of the pSi samples at selected stages of preparation: **(A)** the pSi-PS composite after thermolysis of PS-loaded pSi, and soaking in toluene for 2 h to remove excess unreacted polymer; **(B)** the pSi-PS-PPCS composite after thermolysis of PPCS-loaded pSi-PS composite, and soaking in toluene for 2 h to remove excess unreacted polymer; **(C)** the pSi-PS-PPCS composite after treatment with 0.8% HF(aq) in 10% ethanol (15 min) to remove adventitious silicon oxide; **(D)** the pSi-PS-PPCS composite after treatment with 40% HF(aq) in 10% ethanol (from 10 min to 4 h) to remove adventitious silicon oxide

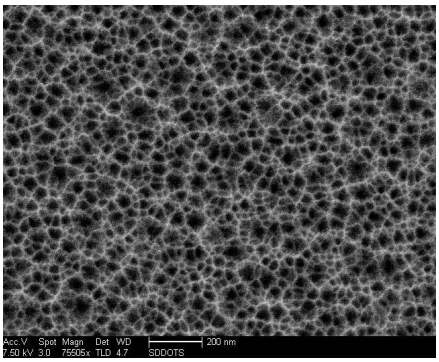
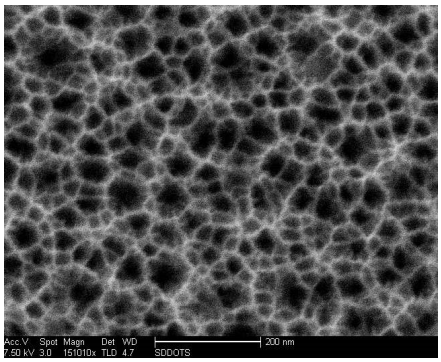
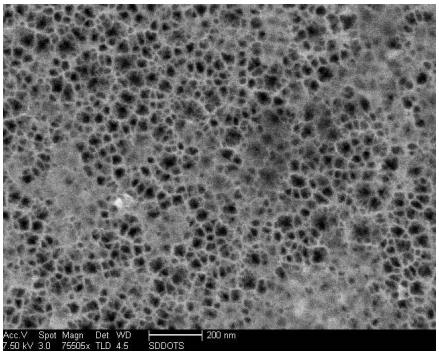
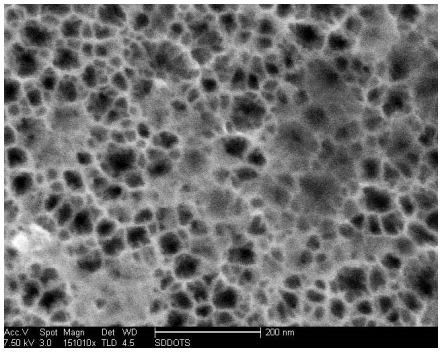
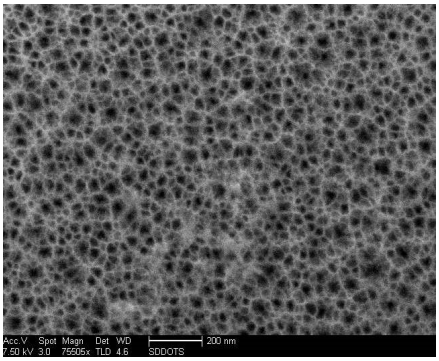
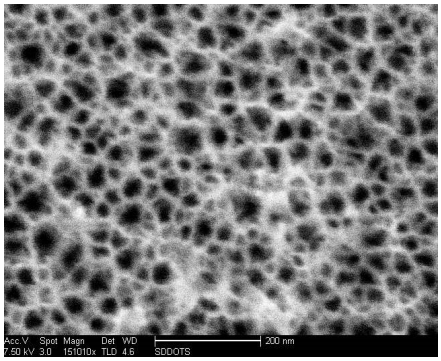
	×75,000	×150,000
Pristine pSi		
pSi-PS		
pSi-PS-PPCS		

Fig. S2. SEM image of pSi, pSi-PS and pSi-PS-PPCS composite at different magnifications.

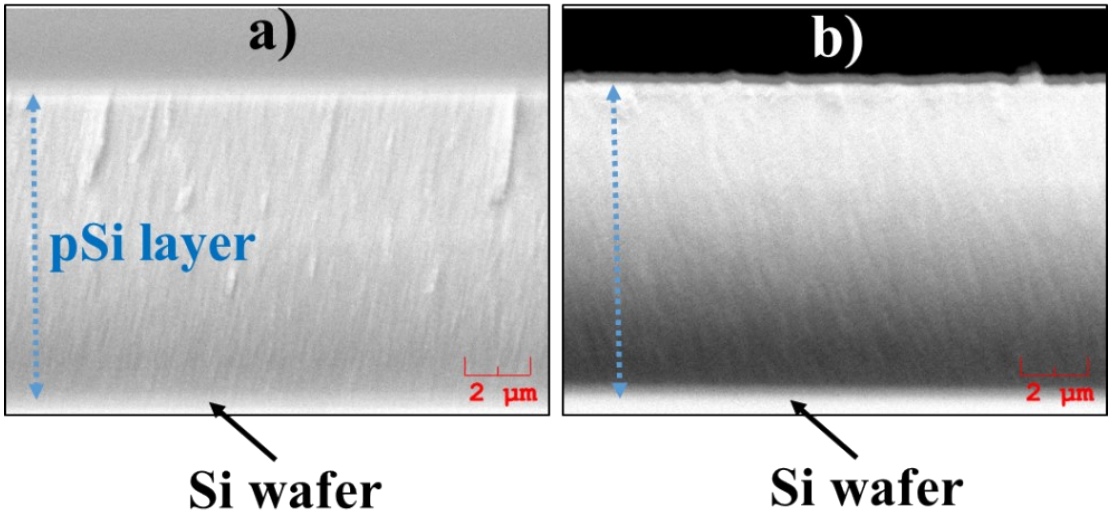


Fig. S3. Cross-sectional SEM images of a) pSi, b) pSi-PS-PPCS.

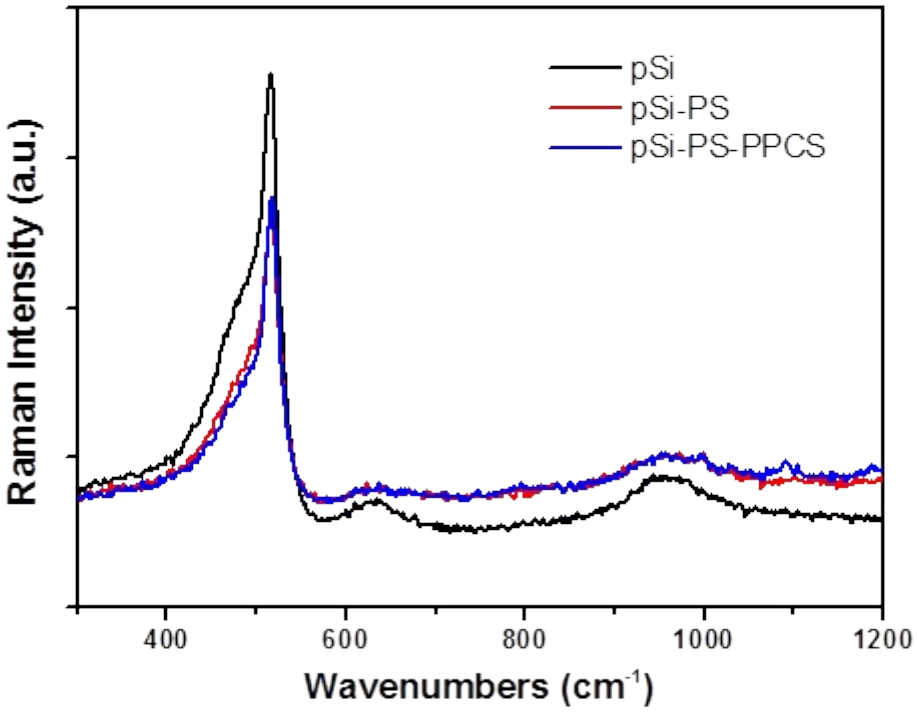


Fig. S4. Raman spectra of Oxidized pSi, pSi composites and PCCS-PS composite.

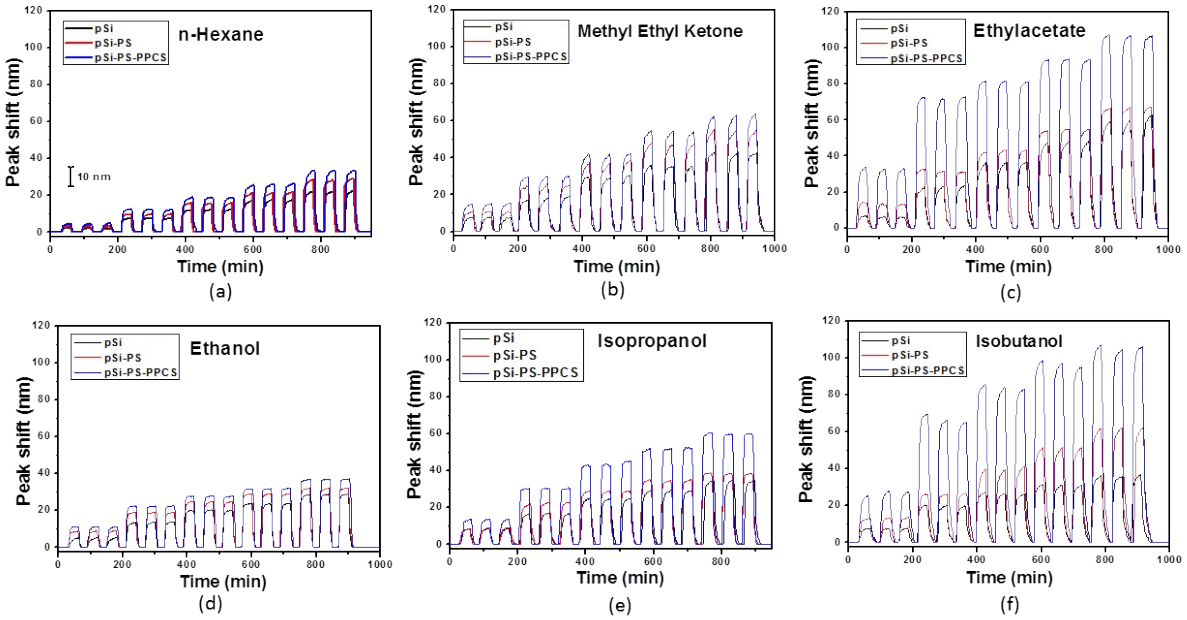


Fig. S5. Peak shift spectra of pristine pSi, pSi-PS, and pSi-PS-PPCS corresponding to the alternative flow (VOC flow/N2 purging) of different VOCs: (a) hexane, (b) methyl ethyl ketone, (c) ethyl acetate, (d) ethanol, (e) isopropanol, (f) isobutanol.

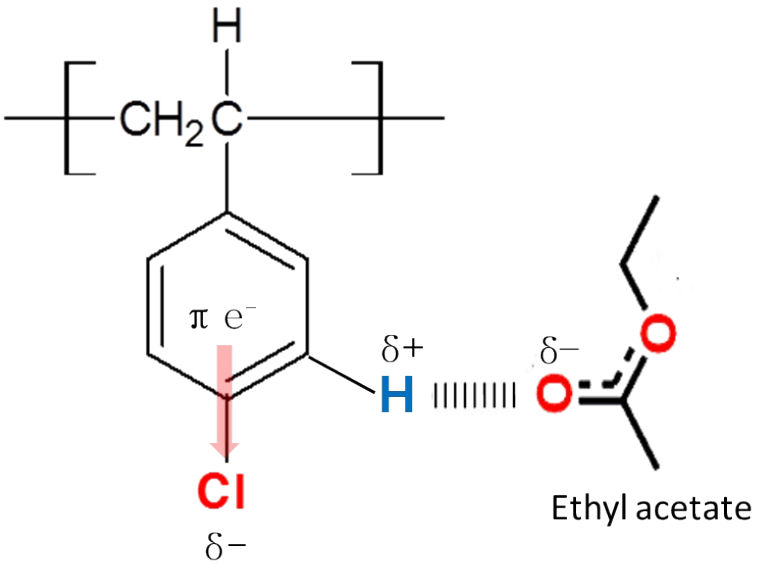


Fig. S6. Plausible hydrogen-bonding interaction mechanism between chlorine-substituted phenyl ring and resonant ethyl acetate.

Table S1. Comparison sensor performance for ethanol between pSi-PS-PPCS chip with other sensor materials.

Material	EtOH	Peak shift (nm)	Limit of Detection	Reference
Freestanding Parylene C and PMMA membrane on Si substrate	2.5 vol%	38.8	--	[1]
Nematic liquid crystal (NLC) film	--	--	247.42 ppm	[2]
Oxidized pSi rugate filter	0.05 P/P_o	~7	--	[3]
Carbonized pSi rugate filter	0.05 P/P_o	~5	--	[3]
PDMS coated micro-nano fiber	140 ppm	10.978		[4]
AgNP-decorated fabric	30-180 ppm	--	30 ppm	[5]
pSi-PS-PPCS	0.1 (vol%)	11.23	--	*This work*
	1.7 (vol%)	37.1	--	

References

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