PAPER www.rsc.org/pccp | Physical Chemistry Chemical Physics

Interfacial water structure at polymer gel/quartz interfaces investigated by sum frequency generation spectroscopy†

Hidenori Noguchi,[a] Minowa Hiroshi,[a] Taiki Tominaga,[b] Jian Ping Gong,[b] Yoshihito Osada[c] and Kohei Uosaki*[a]

Received 27th April 2008, Accepted 10th July 2008
First published as an Advance Article on the web 17th July 2008

Seok, Sangjun (10/1/09)

Motivation

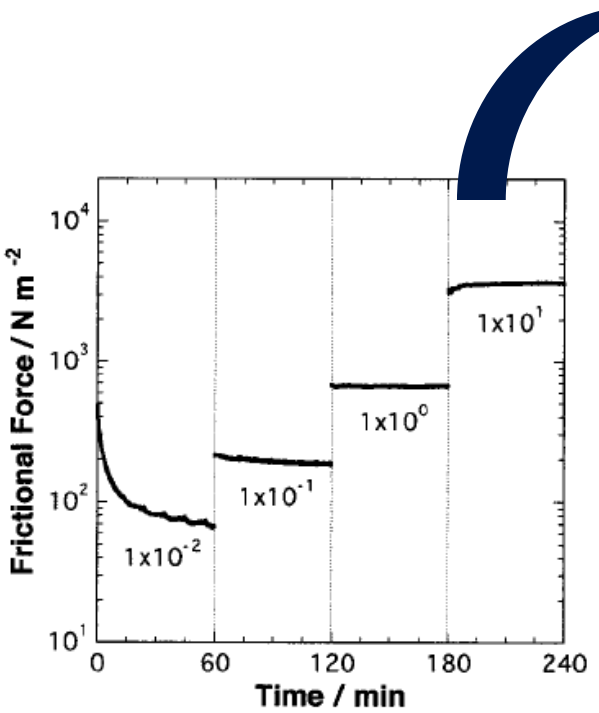


Figure 1. Time profile of the frictional force for a ring-shaped PNaAMPS gel rotated against a piece of PNaAMPS gel under various angular velocities as measured by a rheometer in pure water at 25 °C. The numbers in the figure are the angular velocities in rad/s.

J. Phys. Chem. B **106**, 4596 (2002)

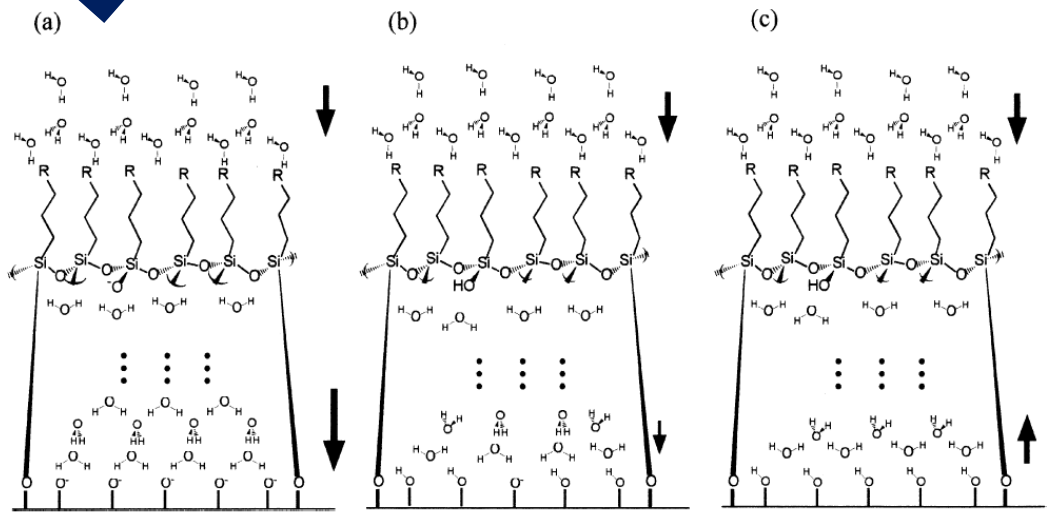


Fig. 10 Schematic structural models of interfacial water molecules on the quartz/OTS/solution interface in (a) alkaline, (b) neutral and (c) acidic phosphate buffered solutions. Arrows show the direction of the dipole moment of the interfacial water molecules.

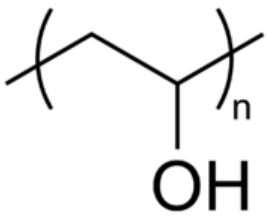
Phys. Chem. Chem. Phys.**3**, 3463 (2002)

서강대학교 SOGANG UNIVERSITY

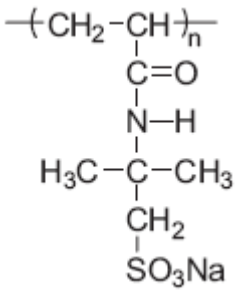
Experimental setup and Sample

Gel sample

Polyvinyl alcohol **(PVA)**

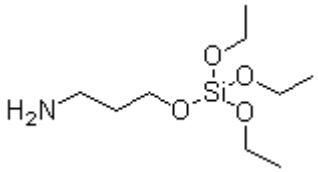


Poly(2-acrylamido-2-methylpropanesulfonic acid sodium salt **(PNaAMPS)**

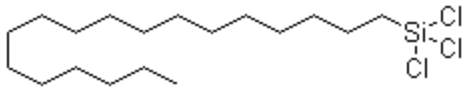


Modified quartz surface

aminopropyltrimethoxysilane **(APS)**



octadecyltrichlorosilane **(OTS)**



Setup

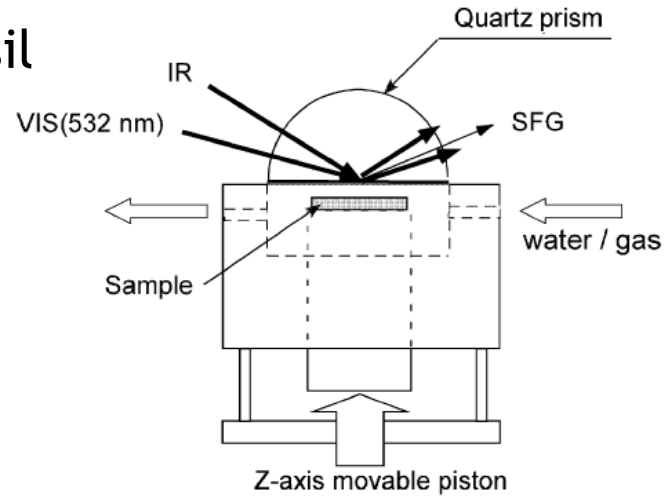


Fig. 1 Schematic illustration of the SFG cell adapted for SFG spectroscopy.

Result - PVA gel/quartz interface

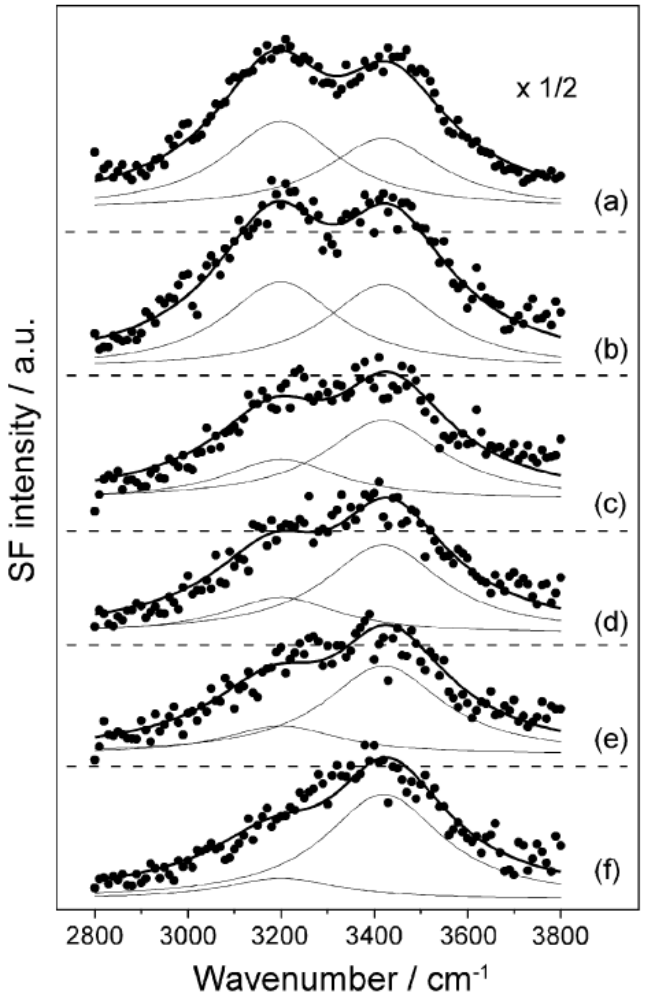


Fig. 2 SFG spectra in the OH stretching (2800–3800 cm^{-1}) region obtained at a quartz surface in water before (a) and after contact of the PVA gel with various applied pressure. (b) 0 MPa (just in contact), (c) 0.2 MPa, (d) 0.4 MPa, (e) 0.6 MPa, and (f) 0.8 MPa.

Layer $_1$ - quartz (n_1 = 1.46)
Layer $_2$ - water (n_2 = 1.33)

Fresnel factor :

$$X_{SSP} = L_{yy}(VIS)L_{yy}(SFG)L_{zz}(IR)\sin(\theta_{IR}) = 1.38$$

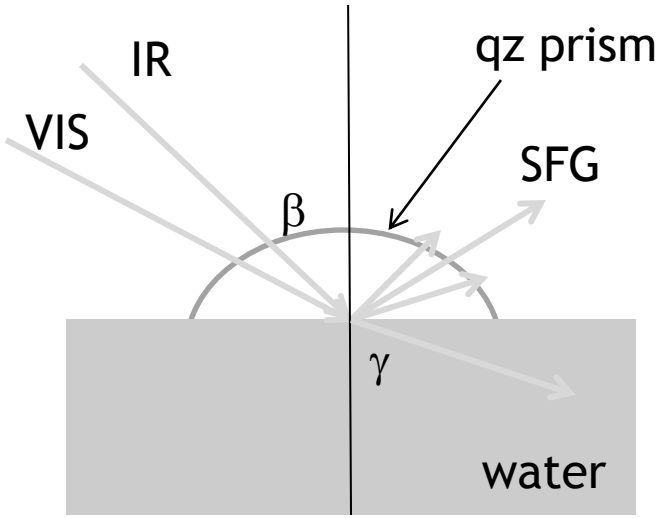
Layer $_3$ - quartz (n_3 = 1.49)

Fresnel factor :

$$X_{SSP} = L_{yy}(VIS)L_{yy}(SFG)L_{zz}(IR)\sin(\theta_{IR}) = 0.065$$

서강대학교 SOGANG UNIVERSITY

PCCP Result - PVA gel/quartz interface



Incidence angle (IR : 50 deg. and VIS : 65 deg.)
quartz (n_1 = 1.46)
water (n_2 = 1.33)

Fresnel factor :

$$L_{xx} = \frac{2n_1 \cos\gamma}{n_1 \cos\gamma + n_2 \cos\beta}$$

$$L_{yy} = \frac{2n_1 \cos\beta}{n_1 \cos\beta + n_2 \cos\gamma}$$

$$L_{zz} = \frac{2n_2 \cos\beta}{n_1 \cos\gamma + n_2 \cos\beta}\left(\frac{n_1}{n'}\right)^2$$

PCCP Result:

$$X_{SSP} = L_{yy}(VIS)L_{yy}(SFG)L_{zz}(IR)\sin(\theta_{IR}) = 1.38$$

0.795 1.105 1.189

Our Calculated Result:

$$X_{SSP} = L_{yy}(VIS)L_{yy}(SFG)L_{zz}(IR)\sin(\theta_{IR}) = 1.99$$

1.53 1.36 1.25

Result – PVA gel/quartz interface

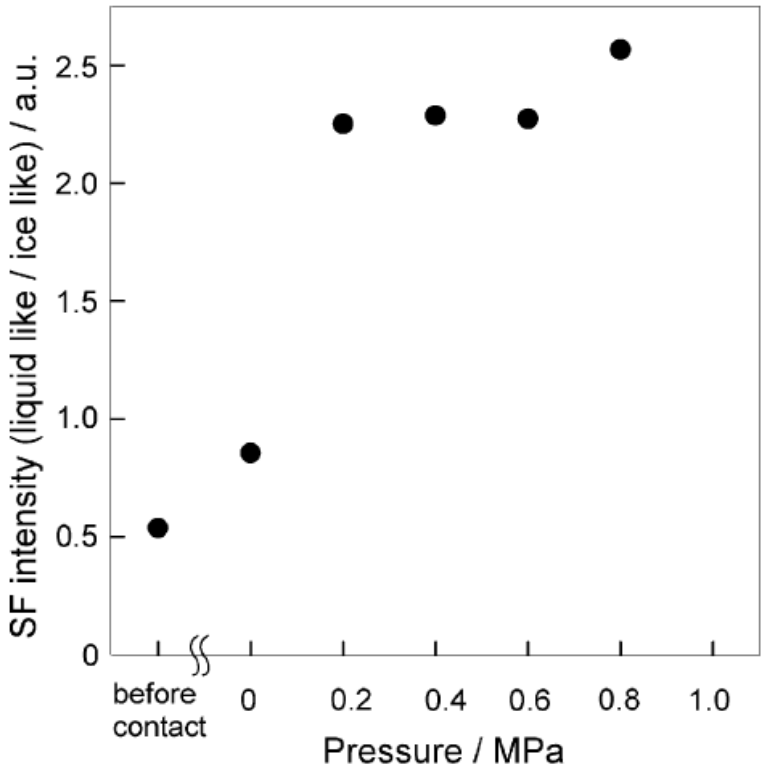


Fig. 3 Effect of applied pressure on the intensity ratio between the SFG signal due to "ice-like" and "liquid-like" water components.

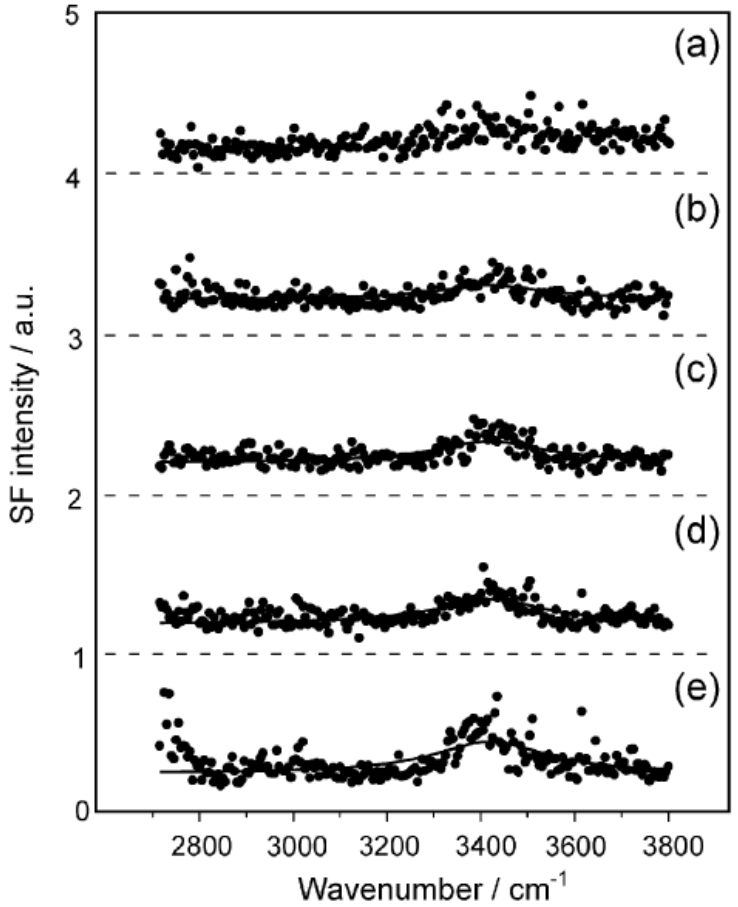


Fig. 4 SFG spectra in the OH stretching (2800–3800 cm^{-1}) region obtained at a quartz surface under an Ar gas flow before (a), and after contact of the PVA gel with various applied pressure: (b) 0 MPa (just in contact), (c) 0.2 MPa, (d) 0.4 MPa, and (e) 0.6 MPa.

서강대학교 SOGANG UNIVERSITY

Result – OTS modified quartz

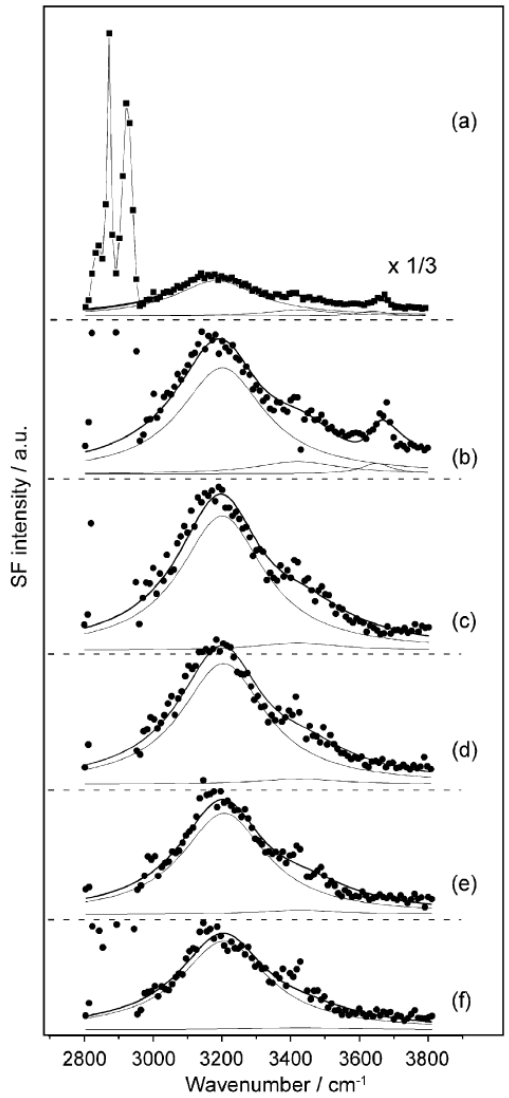
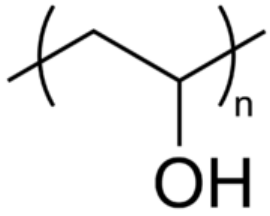


Fig. 5 SFG spectra in an OH stretching (2800–3800 cm^{-1}) region obtained at the OTS modified quartz surface in water before (a), (b) and after contact of the PVA gel with various applied pressure: (c) 0 MPa (just in contact), (d) 0.2 MPa, (e) 0.6 MPa, and (f) 0.8 MPa.

Polyvinyl alcohol (PVA)



서강대학교 SOGANG UNIVERSITY

Result - PNaAMPS gel/quartz interface (APS modified) – pH2

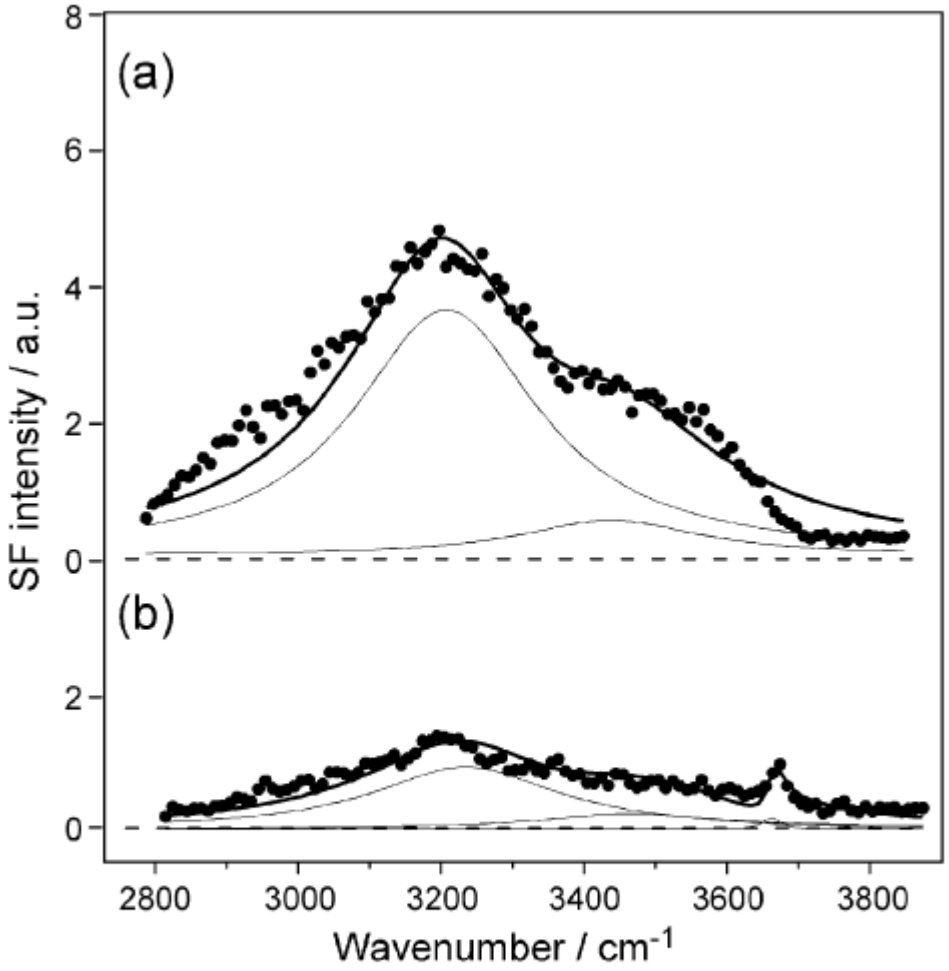
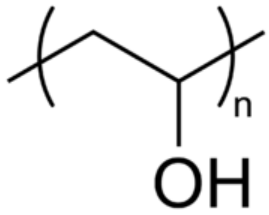
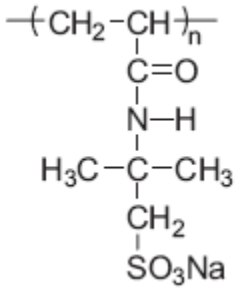


Fig. 6 SFG spectra in the OH stretching (2800–3800 cm^{-1}) region obtained at the APS modified quartz surface in water before (a) and after (b) contact of the PNaAMPS gel in a phosphate buffer solution of pH 2.

Polyvinyl alcohol **(PVA)**



Poly(2-acrylamido-2-methylpropanesulfonic acid sodium salt **(PNaAMPS)**



서강대학교 SOGANG UNIVERSITY

Result - PNaAMPS gel/quartz interface (APS modified) – pH12

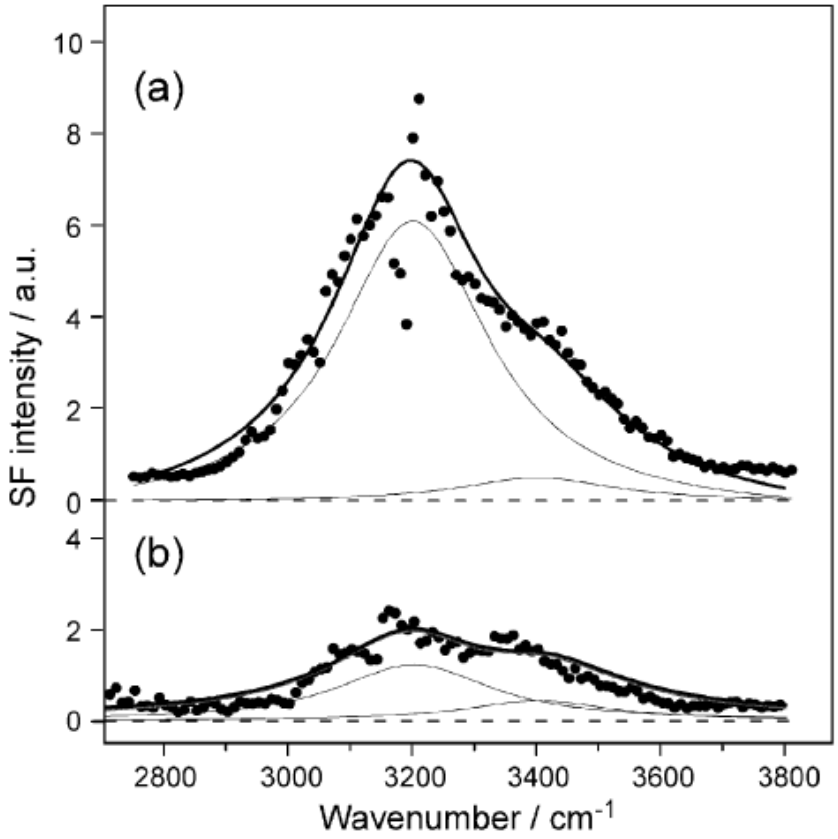


Fig. 7 SFG spectra in the OH stretching (2800–3800 cm^{-1}) region obtained at the APS modified quartz surface in water before (a) and after (b) contact of the PNaAMPS gel in a phosphate buffer solution of pH 12.

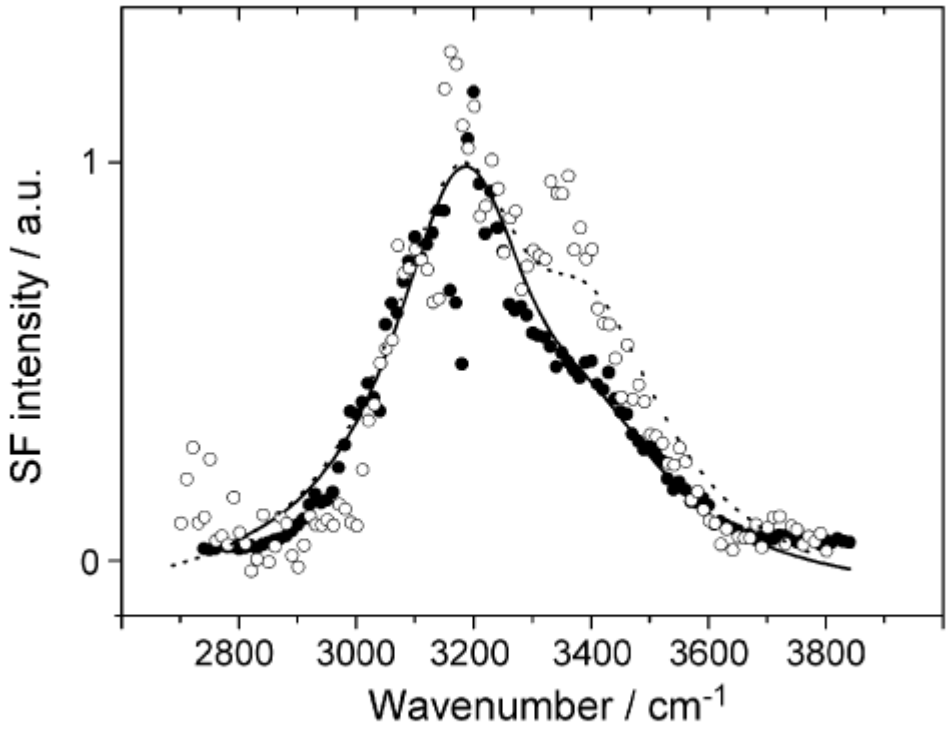


Fig. 8 SFG spectra of Fig. 6 normalized at 3200 cm^{-1} before (●) and after (○) contact of the PNaAMPS gel.

서강대학교 SOGANG UNIVERSITY