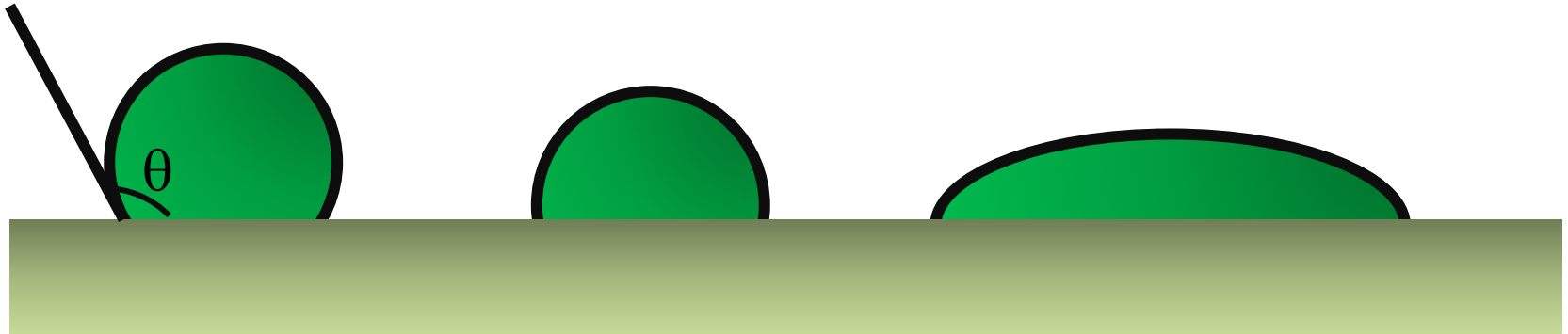# Water Structure at Superhydrophobic Quartz/Water Interfaces :
A Vibrational Sum Frequency Generation Spectroscopy Study

Hidehiko Asanuma, Hidenori, Noguchi, Kohei Uosaki,* and Hua-Zhong Yu*

SEOK, SANGJUN

Wetting

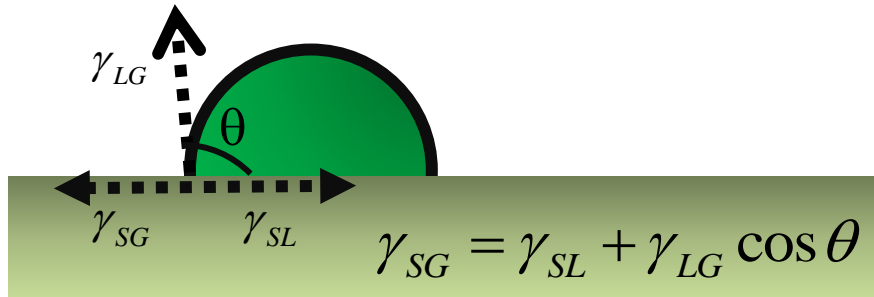**Wetting** is the ability of a liquid to maintain contact with a solid surface

Contact angle	Degree of wetting	Strength of :	
		Sol./Liq. interactions	Liq./Liq. interactions
$\theta = 0$	Perfect wetting	strong	weak
$0 < \theta < 90°$	High wettability	strong	strong
		weak	weak
$90° < \theta < 180°$	Low wettability	weak	Strong
$\theta = 180°$	Perfectly non-wetting	weak	strong

** superhydrophobic, contact angle > 150°*
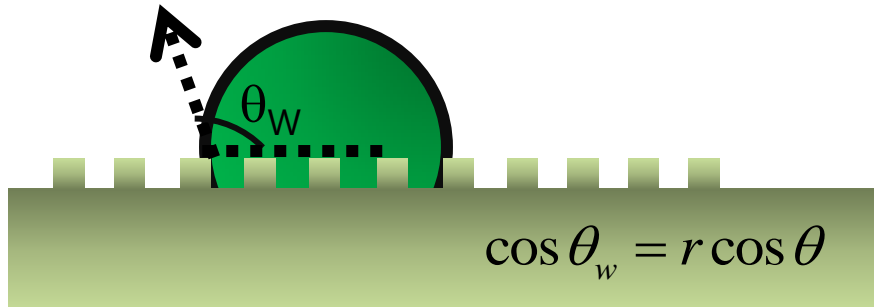
Contact angle θ :

Thomas Young defined :

$$\gamma_{SG} = \gamma_{SL} + \gamma_{LG}\cos\theta$$

Wenzel defined :

$$\cos\theta_w = r\cos\theta$$

Cassie and Baxter defined :

$$\cos\theta_{CB} = r_f f\cos\theta_1 + f - 1$$

Interfacial tension bet.

γ_{SG} Solid and Gas

γ_{LG} Liquid and Gas

γ_{SL} Solid and Liquid

r = roughness factor
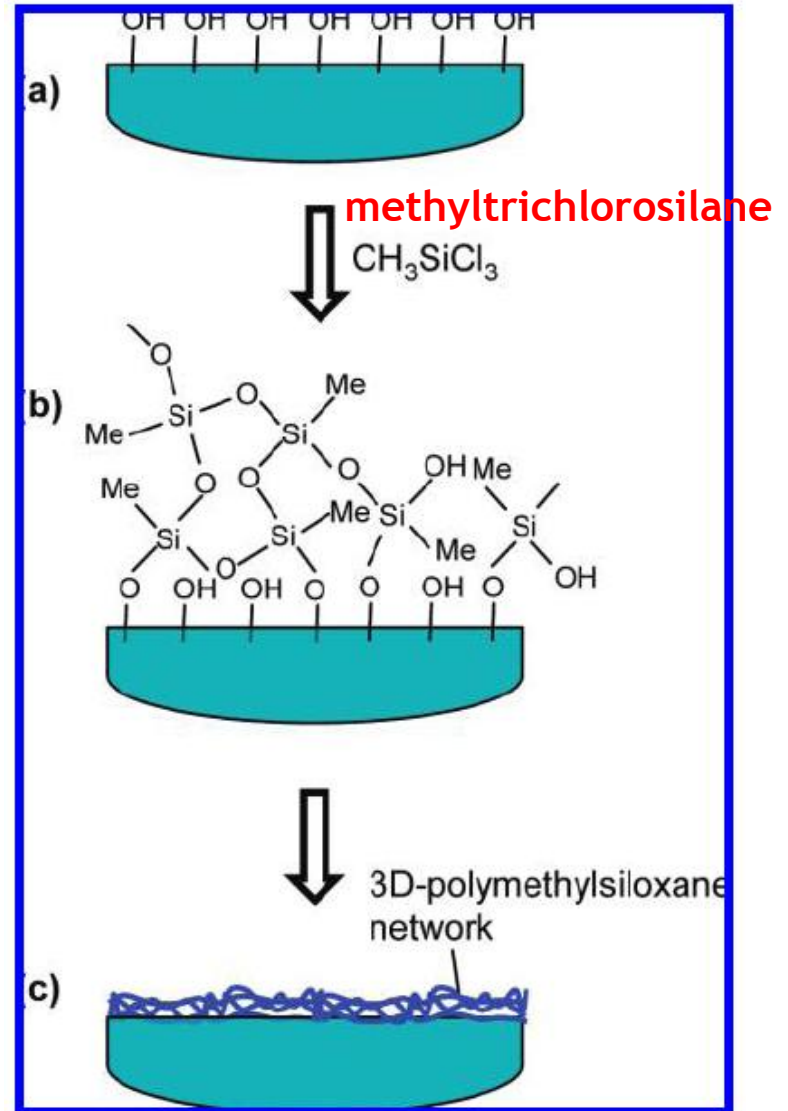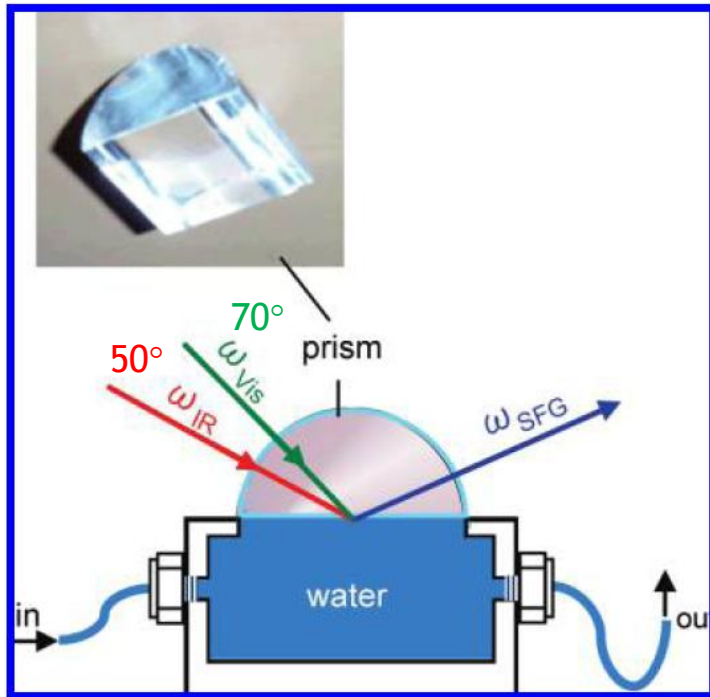   = actual surface /
      geometric surface
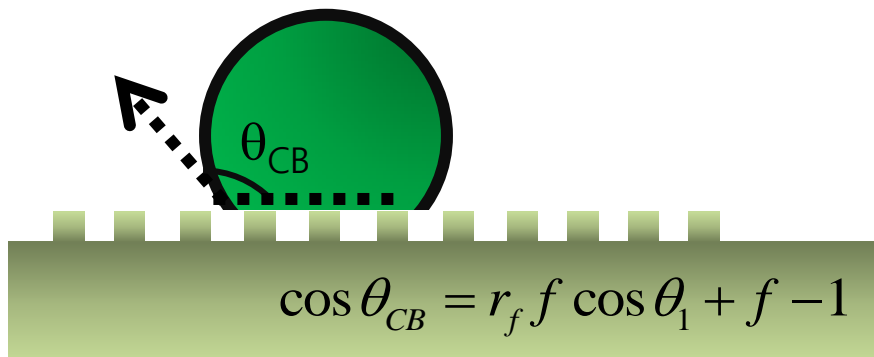
r_f :
the roughness factor of the wet surface

f :
the fraction of solid surface wet by the liquid

Experimental Section

All measurements were carried out at room temperature.

70°
ω Vis
50°
ω IR
prism
ω SFG
in
ou
water

a) OH OH OH OH OH OH OH

methyltrichlorosilane
CH_3SiCl_3

b) Me—Si—O—Si—Me ... Me Si ... OH Me ... Si ... Me ... OH ... OH Me ... O ... OH OH O O OH O
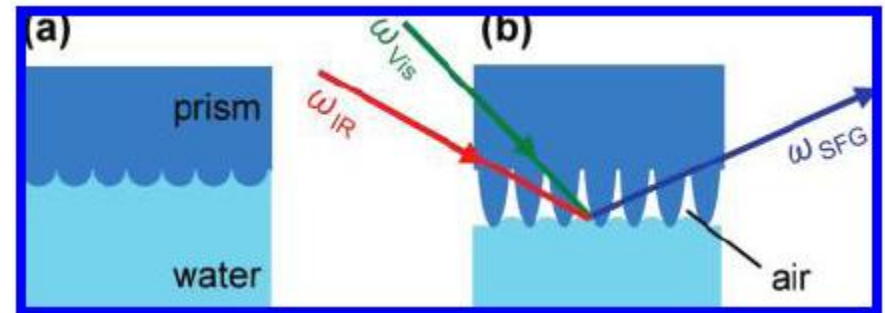
c) 3D-polymethylsiloxane network

Results – surface modified (hydrophilic, hydrophobic, and superhydrophobic)

SEM images surface modified by methyltrichlorosilane
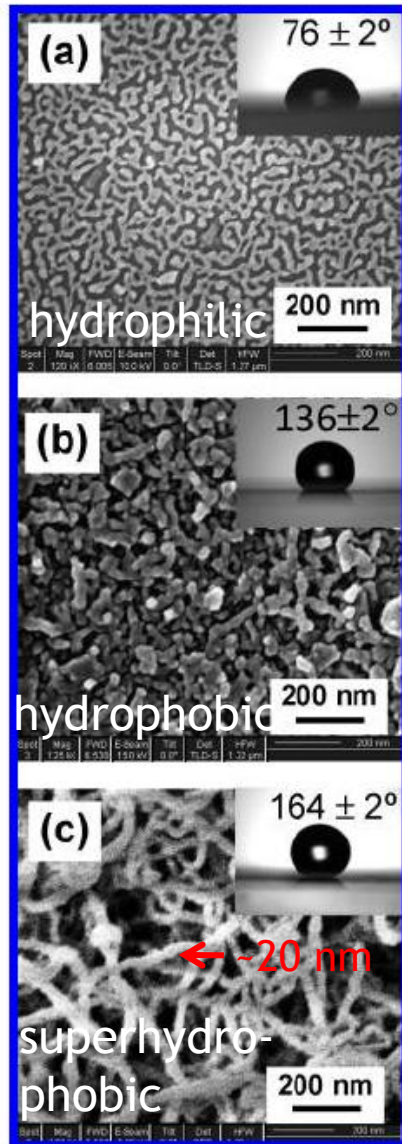
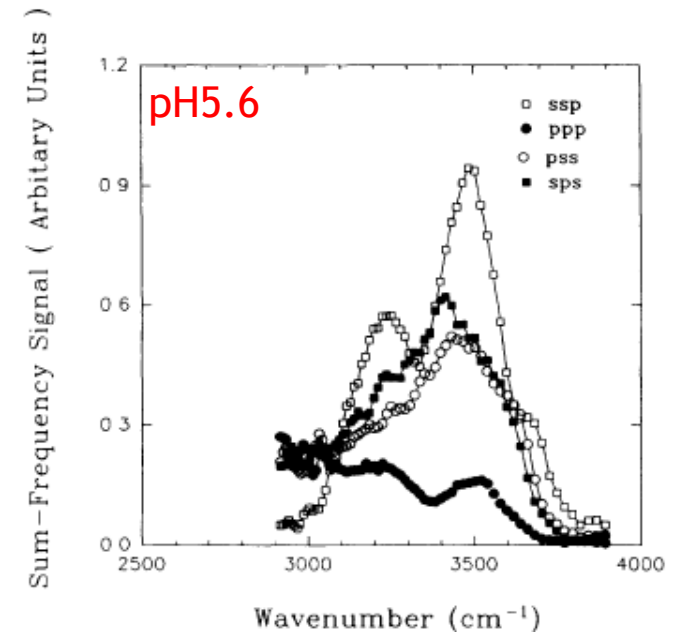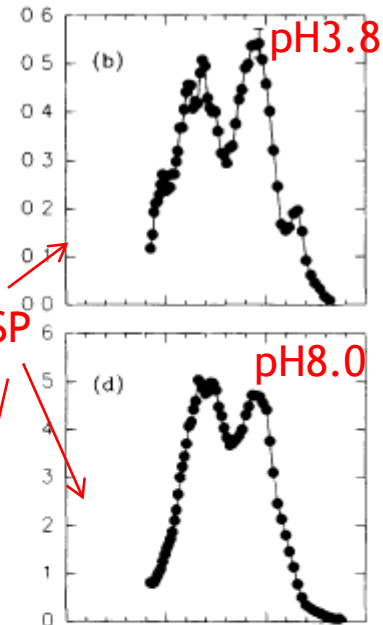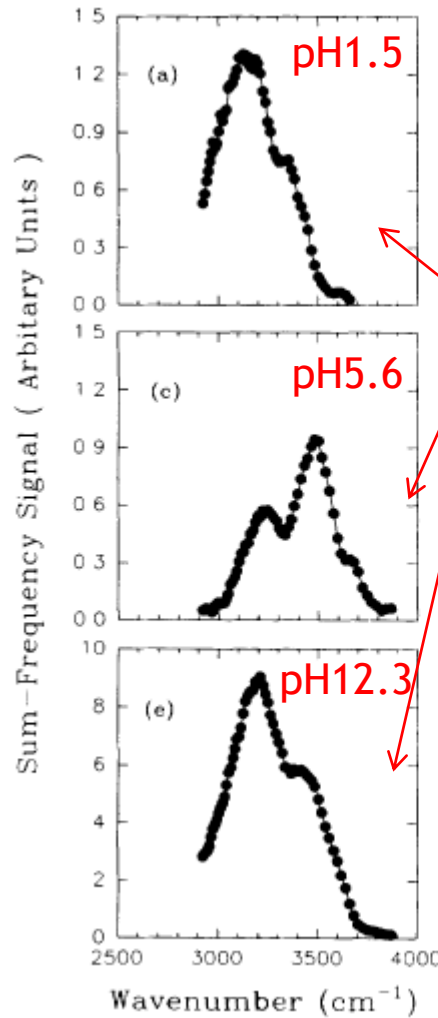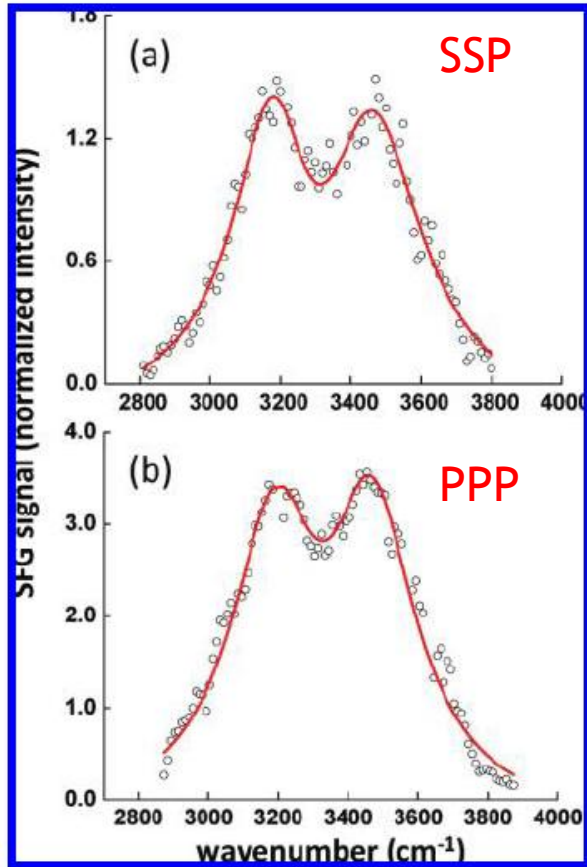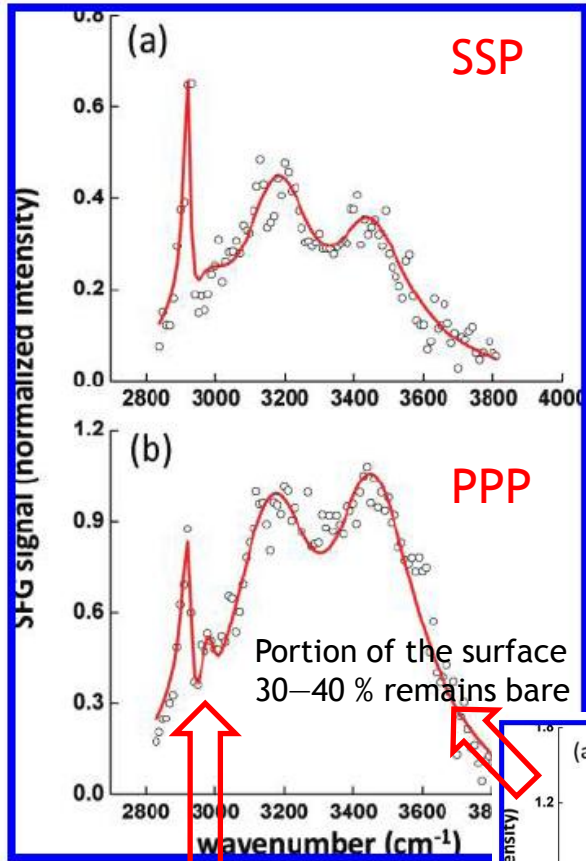Hydrophilic/Hydrophobic surface

Superhydrophoic surface

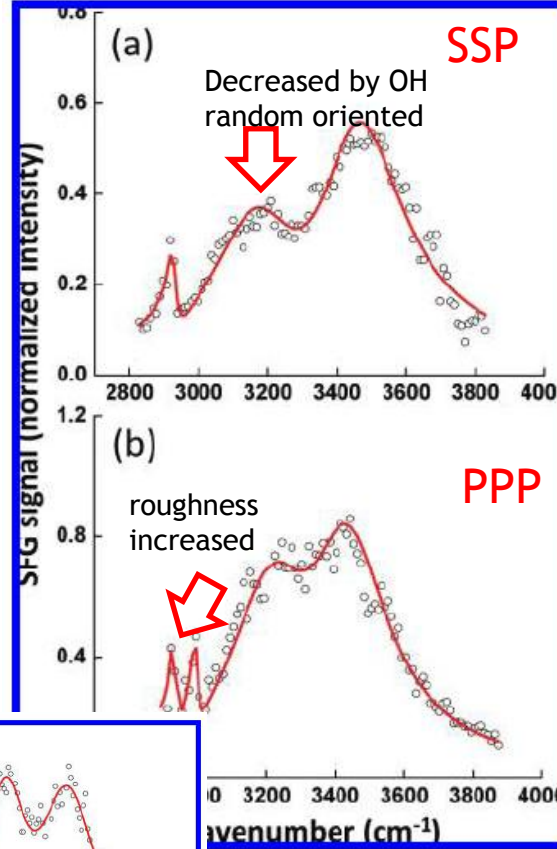# Results – SFG spectra of unmodified qz/H_2O surface (contact angle below 20°)

SSP

PPP

pH1.5

pH3.8

SSP

pH5.6

pH8.0

pH12.3

pH5.6

PRL **72**, 2 (1994)

Results – SFG spectra of modified surface

76±2°

136±2°

164±2°

SSP

SSP

Decreased by OH
random oriented

SSP

PPP

roughness
increased
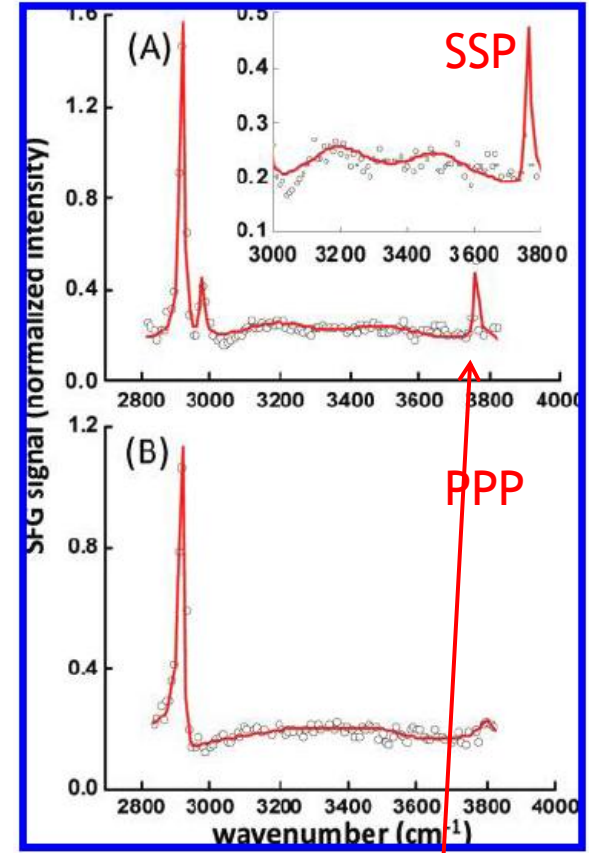
PPP

PPP

Portion of the surface
30−40 % remains bare
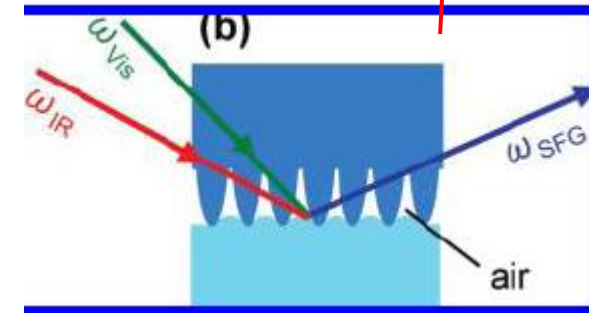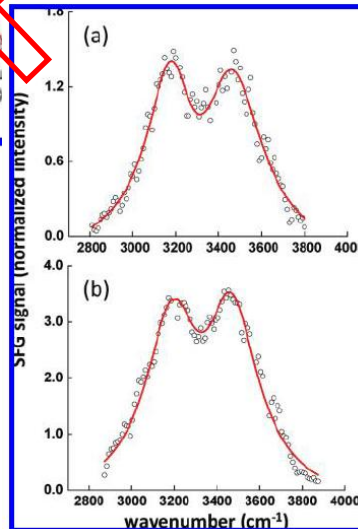
terminal methyl group from
methyltrichlorosilane

(SFG signal (normalized intensity) vs wavenumber (cm^{-1}) axes throughout)

ω_{Vis}
ω_{IR}
ω_{SFG}
air