6. SUM-FREQUENCY GENERATION (SFG)

6.1. Principles of SFG

Shen, Berkeley (1987)

20 groups +

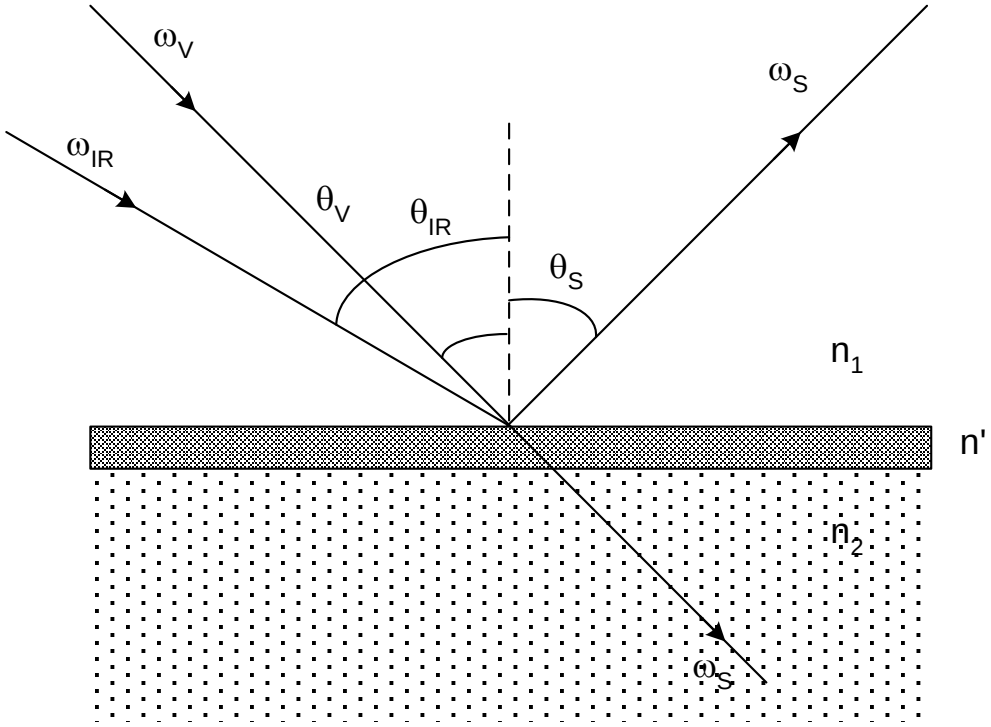
SFG a second order nonlinear optical process when ω_{IR} and ω_V two input lasers generate an output, ω_S

$$\omega_S = \omega_{IR} + \omega_V$$

It is forbidden for systems with inversion symmetry, but at surfaces the inversion centre is often broken.

When omegas (ω) give surface resonance, the SFG is resonantly enhanced.

Applicable **to any interfaces accessible by light**.



Geometry for sum –frequency generation

$\theta_{IR} = 60°$ $\theta_{VIS} = 45°$

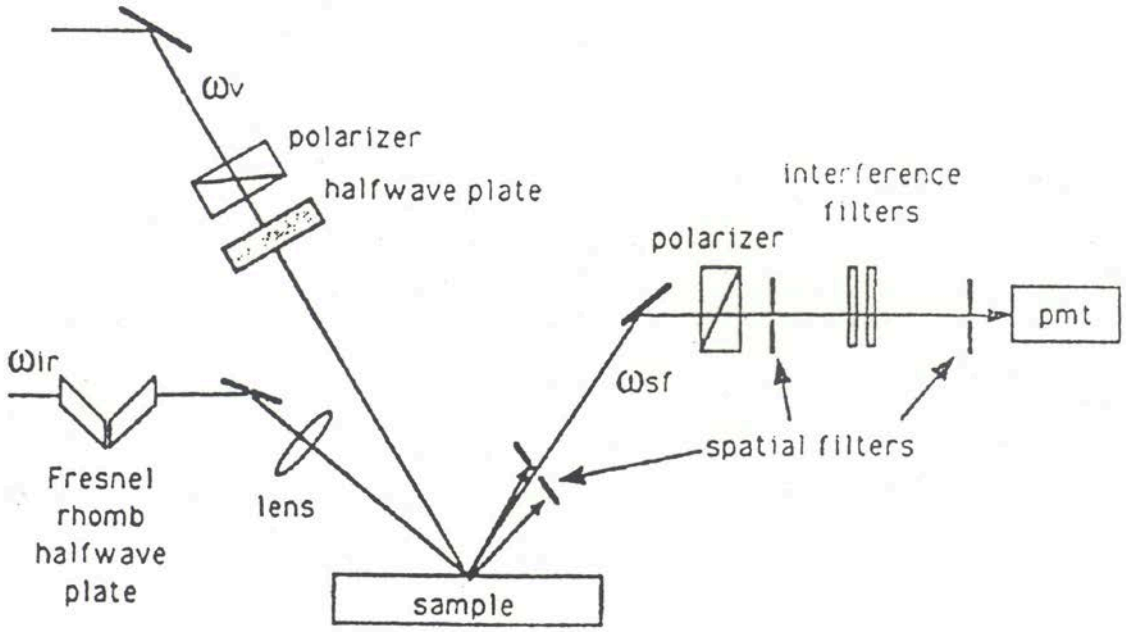
IR-laser: 2.5-10 μm FELIX, free electron laser

VIS-lasers: Nd:YLF (frequency doubled)

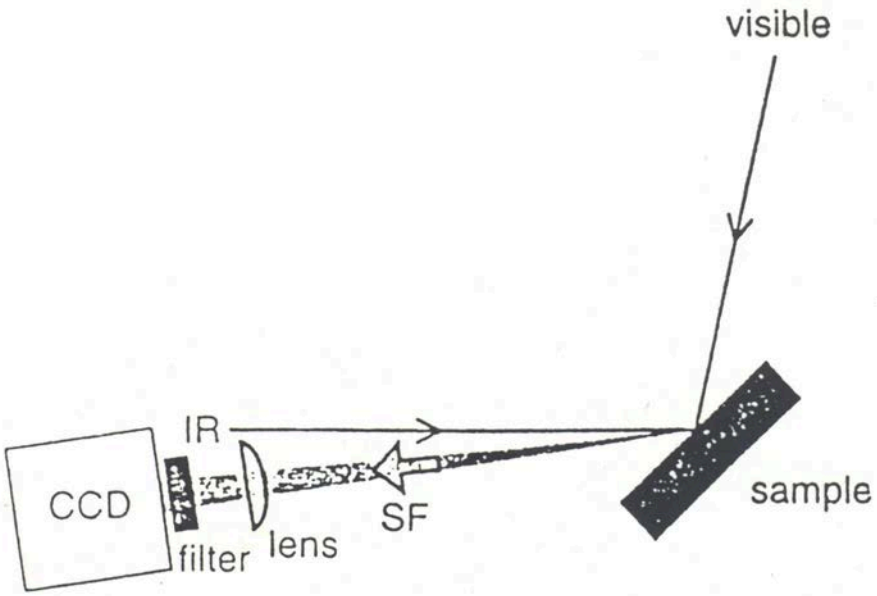
Nd:YAG (frequency doubled)

Impulses: microimpulse 5 μs
Macroimpulse 500 fs – 2 ps

Energy: 8-10 μJ/pulse



Typical set-up for sum-frequency generation

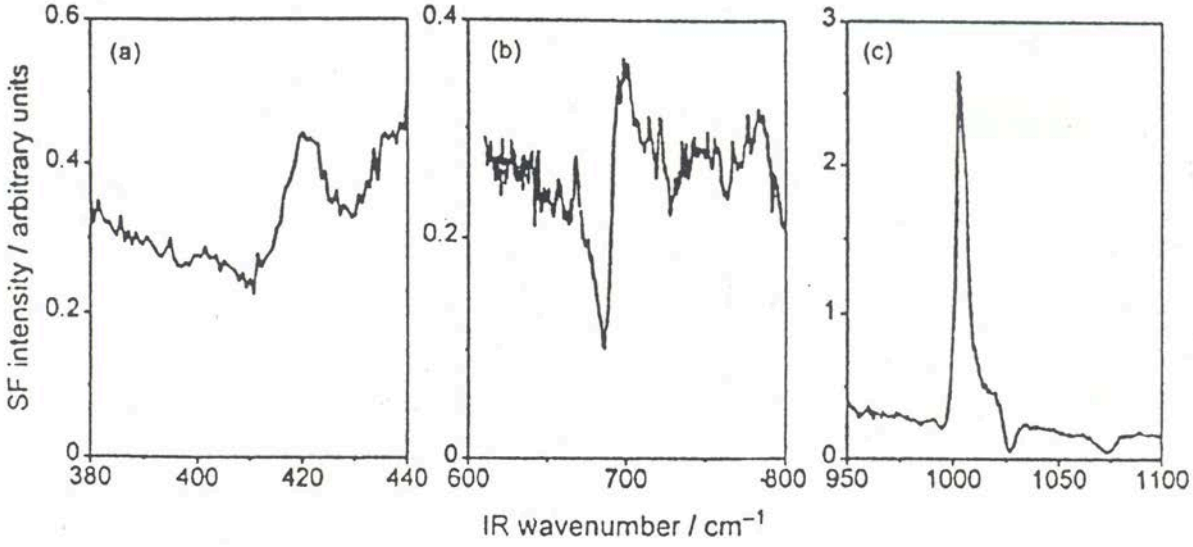


Another experimental arrangement for SFG spectroscopy (counter propagating geometry).

6.2. SOME APPLICATIONS OF SFG

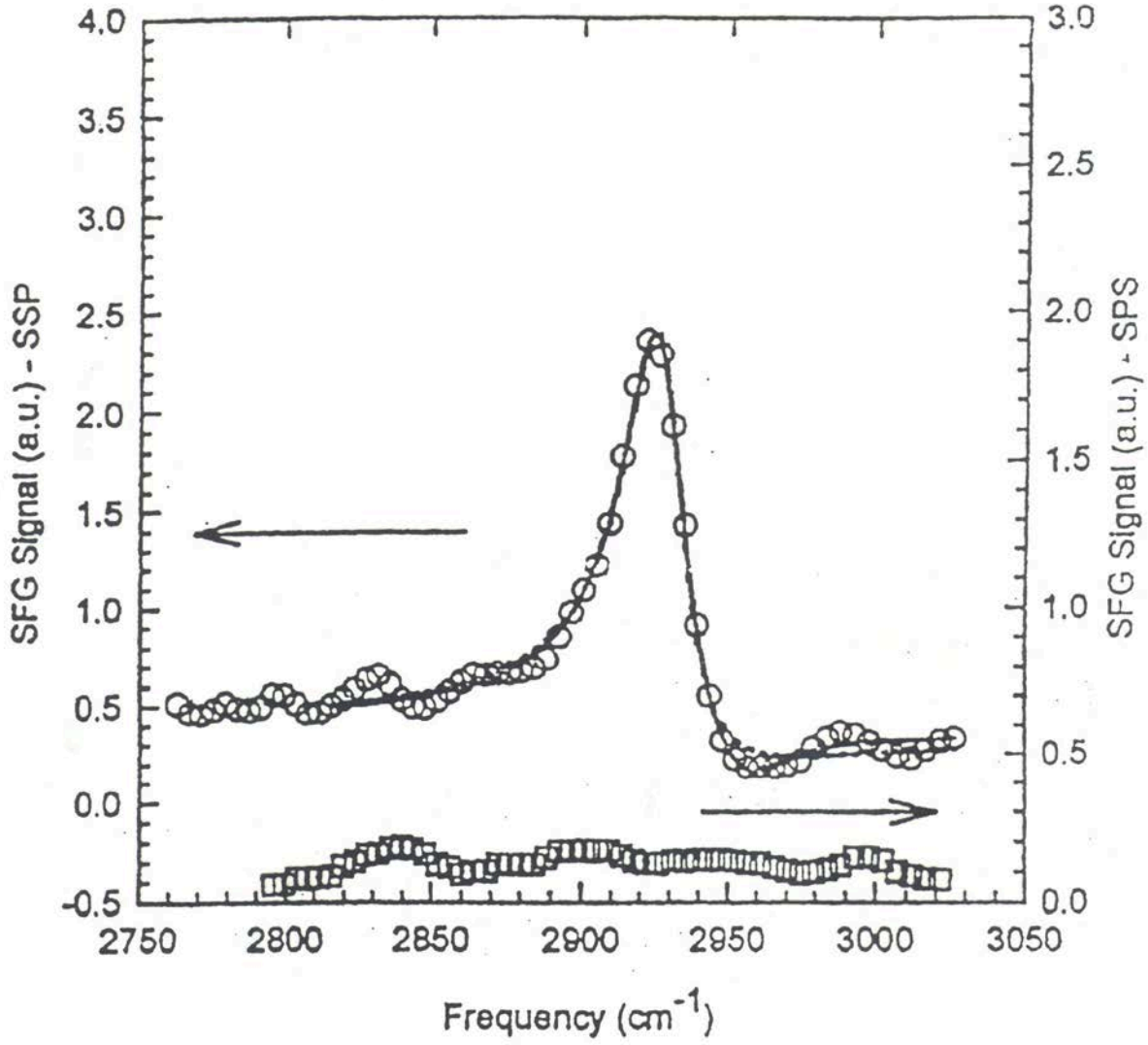
1. Solid/gas

Monolayer of thiophenole (TP) on Ag film (SERS, Auger, EELS, LEED studied before)



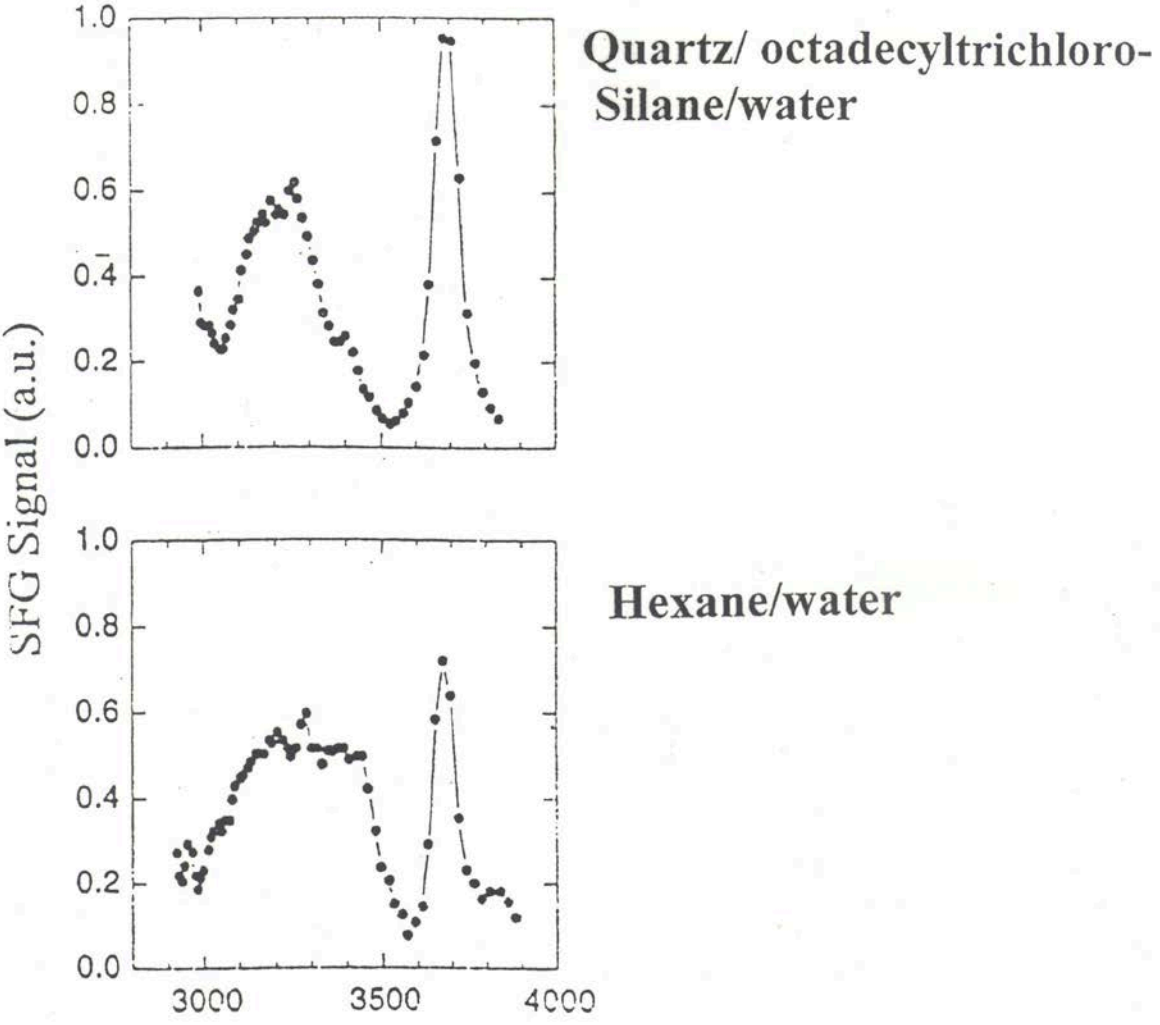
SFG spectra of Ag/TP showing resonances.

2. Liquid/vapour



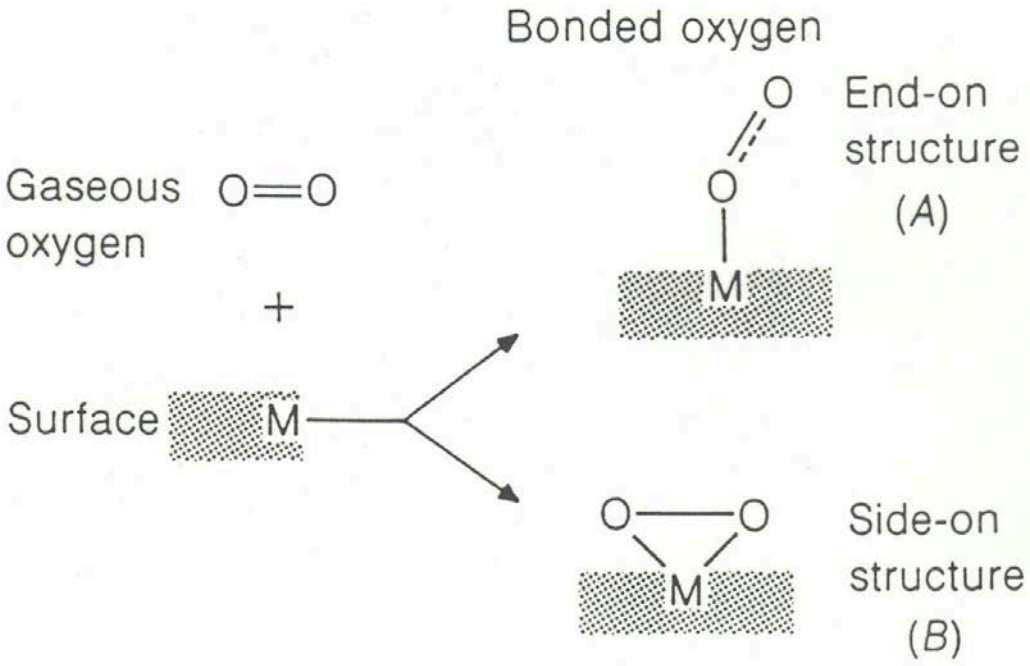
SFG spectra for the liquid/vapour interface of pure **acetone** with (○) **SSP** and (□) **SPS** polarization combinations.

3. Solid/liquid:



SFG spectra of solid/liquid interface (SSP polarization)

CHEMISORBED O_2



Side-on (A) and end-on (B) structures of diatomic oxygen molecule adsorbed on metal surfaces at low temperatures.