# SUM-FREQUENCY GENERATION SPECTROSCOPY

Sum-frequency generation (SFG) spectroscopy is used to assess the vibrational properties of surfaces and interfaces with a monolayer sensitivity. Differently from Raman spectroscopy that is sensitive to the bulk properties, SFG spectroscopy is exquisitely sensitive to the physical and chemical properties of molecular layers at surfaces and interfaces where inversion symmetry is broken.

In SFG spectroscopy, a mid-IR beam is sent onto the surface or interface where it is overlapped with a visible beam. The specific properties of the resulting sum-frequency signal, such as polarization and intensity, provide information on dipole orientation and vibrational spectra at the surface. SFG is a second-order non-linear process and is allowed only when inversion symmetry is broken, making it a specifically surface-sensitive method. The time resolution of such spectroscopy can be implemented using a pump-probe configuration. In this type of spectroscopy, one of the pulses is required to have a sufficiently narrow spectral bandwidth in order to have a high spectral resolution.

Broadband mid-IR source such as **ORPHEUS-MIR**, pumped by **PHAROS** or **CARBIDE** laser, addresses many vibrational levels at the same time, while SHBC is used to double the laser frequency and narrow down the spectral bandwidth to match the narrow vibrational linewidth requirements of SFG spectroscopy. In this configuration, the SFG signal is generated in the visible spectral range, eliminating the need for a complex infrared detection.

## Broad-Bandwidth Mid-IR Optical Parametric Amplifier


- Broad-bandwidth up to 500 $cm^{-1}$
- 2500 – 10000 nm tuning range
- < 100 fs pulse duration
- Up to 80 W pump power
- Up to 2 mJ pump pulse energy

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