18èmes Journées de la Matière Condensée
22-26 août 2022, Lyon

Société Française de Physique

Sonder les propriétés d'interfaces fluides par des techniques d'optique linéaire et non-linéaire

2 pages maximum en anglais ou français

1. **Organisateurs (avec affiliation, usuellement 2 ou 3 personnes) :**

Oriane BONHOMME, Institut Lumière Matière, Villeurbanne (France) (+ Claire LOISON, ILM)
Olivier DIAT, ICSM -CEA Marcoule (+ JF Dufrêche, ICSM)

2. **Parrainage ou lien avec des sociétés savantes, des GDR ou autres structures :**

Ce mini-colloque est soutenu par les GDR ISM et SOLVATE.
Ce mini-colloque s'inscrit également dans la lignée de projets coordonnés par les organisateurs ANR JCJC *SOLSTICE* ANR-21-CE30-0007 (PI O. BONHOMME), FETOPEN H2020 *PROGENY* Grant agreement ID: 899205 (co-PI O. BONHOMME), IRP CNRS *NISI* (PI O. DIAT)

3. **Résumé de la thématique du minicolloque :**

Fluid interfaces (liquid/liquid or liquid/gas) are ubiquitous in numerous scientific fields because they are more or less specific and stabilizing adsorption domains and because they are the medium, however thin they may be, of exchanges between two immiscible and adjoining phases. When they are developed for, these interfaces favor exchanges or dispersion properties specific to an activity or a function sought. In the liquid/liquid field, such as in solvent extraction for example, they play a fundamental role in depollution and separation mechanisms for recycling or waste treatment. In the liquid/gas field, they play a role in wetting, friction and even flotation, extraction and transport, accelerating transverse transport processes due to interfacial confinement. Emulsion interfaces, foam interfaces, bio-cellular interfaces are part of these active interfaces resisting to physico-chemical stresses and evolving in time. Finally, such interfaces can also provide softness and unctuosity of divided media through their connectivity or act as barriers that can target specific and regulated exchanges.

While crucial, characterizing the structure and dynamics of such interfaces remains a challenge, notably when this interface is out of equilibrium. So, it is important to probe these interfaces, which can be blurred or not, in the most non-invasive way as possible.

Linear and/or non-linear optics remain techniques of choice, especially if structural and spectral aspects can be coupled. In linear optics, studies with polarized light beams such as ellipsometry on reflected or scattered light allow measurements of the thickness and the refractive index of adsorbed layers and also to have access to the dynamic (order of magnitude of the millisecond) aspects of the underlying aggregation systems. As another example, fluorescence correlation spectroscopic techniques allow the quantification of the dynamics of fluorescent probes at the interface as a function of the surrounding interfacial medium properties, and then to probe dynamic properties of the interfaces. The 2nd-order non-linear optic processes, including the second harmonic generation (SHG) and sum frequency generation (SFG) techniques, are also tools of choice to question the structure of liquid interfaces

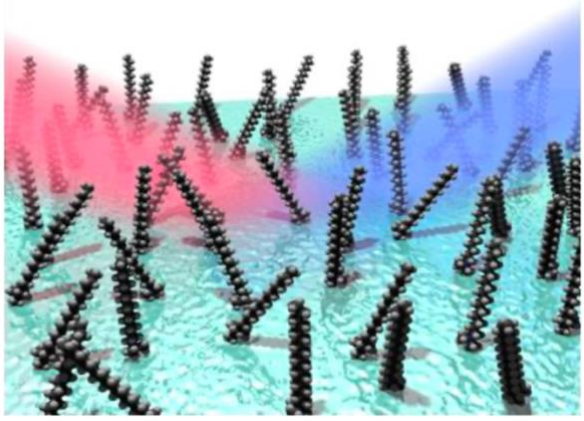

Illustration of SHG experiments on liquid/air interface

[Costa2020, Dalstein2020]. Indeed, such processes are based upon the conversion of two photons at the fundamental frequency(ies) into one at higher energy. Due to symmetry reason, this process is forbidden in perfect centrosymmetric media. Thus, they are methods of choice because they are interfacial specificity, the volume terms canceling on average.

However, the interpretations of the linear and non-linear optical signals at the molecular scale are often model dependent and suffer from a use reserved to experts that have prevented its popularization. Indeed, although recent theoretical studies have proven the efficiency of theoretical tools such as molecular dynamics (classical and *ab initio*) for interpreting SFG [Kroutil2020] and SHG [Foucaud2021, LeBreton2021] signals, predicting such experiments requires accurate models allowing to correctly describe the molecules at the interfaces but also in the bulk.

The first aim of this mini-colloquium is thus to present recent studies where linear and non-linear optic methods are used to probe properties of liquid/liquid and liquid/gas interfaces, with a wide range of applications from biology to physics and chemistry. The second aim of this mini-colloquium is therefore to gather experimentalists and theoreticians to present recent advances on the modeling in links with the experiments.

Questioning fluid interface properties through optical means is a very active research subject nowadays in France (for example at ILM, ICSM, LOMA, ICGM, ICS, …) but also internationally. We suggest a list of potential invited speakers that illustrates (in a non-exhaustive way) this national and international context:

- *SFG on lipidic membranes* : Francesca CECCET (Namur Univ)
- *Numerical prediction of SFG signal*: Marie-Pierre GAIGEOT (Univ. Evry), Benoit CHAMPAGNE (Namur Univ)
- *SHG on liquid/air or liquid/liquid interfaces:* Laetitia DALSTEIN (Univ. Bordeaux), Ellen BACKUS (Vienna Univ.), Eric VAUTHEY, (Univ. Genève)
- *Ellipsometry on adsorbed layer:* Antonio STOCCO (Univ. Strasbourg), Colin BAIN (Durham Univ.)

Moreover, this mini-colloquium is more generally addressed to people interested in science of fluid interfaces, such as teams specialist in liquid foams science, liquid/liquid extraction, etc. A special care will then be brought to plan a broad audience introduction to optical techniques at the beginning of the colloquium.
We expect 40 to 50 participants to this mini-colloquium.

Références (chosen in French community)

[Costa2020] R. Costa, C. Pereira, AF Silva, PF Brevet, E. Benichou, J Phys. Chem. B, 124, 3954 (2020)
[Dalstein2020] L. Dalstein JR. Huang, YC Wen, Opt. Lett., 45, 3733 (2020)
[Kroutil2020] O. Kroutil, S. Pezzotti, M.-P. Gaigeot, M. Prědota. J. Phys. Chem. C, 124, 15253 (2020)
[Foucaud2021] Y. Foucaud, B. Siboulet, M. Duvail, A. Jonchère, O. Diat, R. Vuilleumier, J.-F. Dufrêche. Chem. Science, 12, 15134 (2021)
[Le Breton2021] G. Le Breton, O. Bonhomme, PF. Brevet, E. Benichou, C. Loison. Phys. Chem. Chem. Phys., 23, 24932 (2021)