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Deep (thermo)dynamic alterations upon the water wetting on a solid

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At the liquid/solid interface, the liquid energy is different from that of the bulk due to the imbalance between intermolecular and surface interactions. Similar to external fields such as electric, magnetic, or flow fields, the vicinity of a solid surface can preclude the liquid molecules from relaxing to equilibrium. It is here shown that this non-equilibrium state is also associated to the generation of located temperature gradients in the liquid [1]. This unforeseen thermal effect; i.e. the co-existence of (non-Fourier) thermodynamic states, supports the picture of a correlated liquid state [2] that may be related to a surface induced molecular polarization [3]. We ask now the mirror question: does the wetting also impact the solid?

In a second part of the presentation, we probe the evolution of solid dynamics (atomic (phonon) vibrations) upon wetting, using inelastic X-Ray scattering. We reported significant ($> 1\text{meV}$) hardening of the phonons modes of the solid (sapphire crystal) due to wetting for both transverse and longitudinal acoustic phonons at a penetration depth of roughly $150\ \mu\text{m}$, thus well below the wetted surface [4].

These results may suggest a new definition of the liquid/solid interface as an extended intermediary zone dynamically affected by the presence of the liquid, far beyond the usual interfacial considerations. In essence, the results highlight a possible long range phonon liquid/solid coupling. This is in agreement with the assumption that liquids can propagate shear waves as already suggested by the identification of shear elasticity [2] and thermoelastic effects describable by the Biot theory coupling elasticity to temperature changes [5, 6].

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