Amplitude-modulation atomic force microscopy at the solid/liquid interface: imaging water, ions and liquid self-assembly

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Recent development in the field of atomic force microscopy have made it possible to routinely achieve atomic- or molecular-level images of solid/liquid interfaces and quantify the behaviour of solvation structures locally. Typical measurements are based on the frequency- or amplitude-modulation of a cantilever vibrating with sub-nanometre amplitude. Here I present high-resolution amplitude-modulation measurements over two different types of interfaces. The first type involves solids in contact with aqueous solutions containing ions. Such interfaces are of fundamental importance in biology and in electrochemical processes. The results, complemented by MD simulations, show that interfacial water can induce correlations between single metal ions at various soft and hard interfaces, create ordered ionic structures, and dramatically slow down the dynamics of adsorbed ions. The second system is composed of soluble liquid mixtures that tend to demix at the interface, creating dynamical self-assembled structures that can rapidly heal when damaged. Aside from its enormous potential in technology, this type of interfaces offer unique insights into the poorly understood transition between bulk and surface thermodynamics. In both cases, I discuss the impact of the measurement process on the results and on the resolution achieved.