

As accessible experimental length scales become shorter, the modification of interfacial properties of water using electric field must come to grips with novel effects existing at the nanoscale. I will briefly survey some of our recent progress we have made in understanding these effects using molecular simulations.

Polar molecules at nanoparticle surface and/or under nanoconfinement feature a strongly anisotropic response to applied electric field, biased toward dipole orientations parallel to solid/liquid interface. In water, in particular, this effect combines with generic orientational preferences induced by spatial asymmetry of water hydrogen-bonding under confined geometry. The two effects are reflected in considerable dependence of water polarization and surface wetting on both the field direction relative to the interface, and the polarity (sign) of the field (Figure 1). We suggest a new mechanism to orient nanoparticles by an applied electric field even when the particles carry no charges or dipoles on their own. Coupling to the field can be accomplished through solvent-mediated interaction between the applied electric field and a nanoparticle. For nanoscale particles in water, we find the response to the applied field to be sufficiently fast that this mechanism is likely to be relevant for biological processes, for the design of novel nanostructures and sensors, and development of nanoengineering methods.

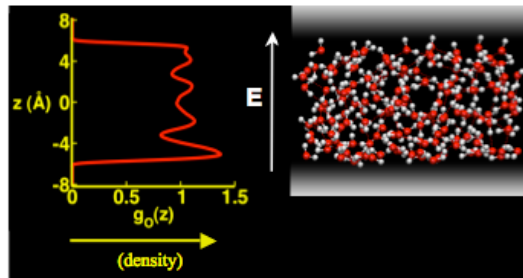


Figure 1 demonstrates the principles of molecular effect of electrowetting: When electric field is applied in the direction perpendicular to the confining paraffin-like soft walls, the competition between field-induced alignment and orientational preference of interfacial water molecules relative to the surfaces results in *asymmetric* wettability of opposing surfaces, with water favorably attracted to the surface on one side but abhorred on the other (*Janus* interface).