The desire for oil and water molecules to separate is well known. In spite of the many commercial applications, the interface between water and a hydrophobic liquid (or oil) is one of the more unexplored areas of fundamental surface science. In recent years increasing attention has been focused on obtaining such an understanding because of its relevance to topics such as to oil spill remediation, protein folding, “on-water” reactions, chemical separation, oil extraction, nanoparticle formation and interfacial polymerization. In this presentation I show what unique insights we have obtained about the structure and bonding of molecules at the oil-water junction and how the fascinating structural characteristics of this interface foster the ordered assembly of ions, amphiphiles, polymers and nanoparticles. Our studies involve a combination of nonlinear and linear spectroscopic techniques, thermodynamic measurements and molecular dynamics simulations.