character from the water beyond the exclusion zone and the differences are appreciable. EZ water is more viscous and more stable than bulk water, its molecular motions are more restricted, its light-absorption spectra differ in the UV-visible light range, as well in the infrared range, and it has a higher refractive index. These multiple differences imply that EZ water fundamentally differs from bulk water. The EZ hardly resembles liquid water and thus an unexpected feature of water has been identified. Next to hydrophilic surfaces, water molecules organize into liquid crystalline arrays building EZ honeycomb layers, which can project unexpectedly far from their nucleating surfaces. Like crystals of ice, these liquid crystals exclude many substances ranging in size from macroscopic colloidal particles to submicroscopic solutes. Those EZ layers can slide past one another if sufficient shearing force is applied, but ordinarily the planes stick to one another, creating what is seen macroscopically as the EZ (Fig. 6).

On hydrophobic surface (Lee et al. 1984) the orientation of water molecules near the surface is biased so that hydrogen bonding groups tend to avoid a direction toward the nonpolar material, which cannot itself participate in hydrogen bonding. Water thus maintains a hydrogen bonding interaction, which is comparable to that in the bulk. The liquid structure nearest the surface is characterized by "dangling" hydrogen bonds, i.e., a typical water molecule at the surface has one potentially hydrogen-bonding group oriented toward the hydrophobic surface. The density extends at least 10 Å into the liquid, and significant molecular orientation preferences extend at least 7 Å into the liquid. Still it appears that whatever the substrate, the spatial range at which water structure is perturbed is rather limited, less than 15 Å from the surface.

In both hydrophilic (Cicero et al. 2005) and hydrophobic cases (Lee et al. 1984), the properties of the confined water become more like those of the bulk with increasing distance from the surfaces. Moreover all the macromolecules are characterized by alternate hydrophilic and hydrophobic moieties with different characteristics. Therefore, one can assume that unusual water observed at mosaic hydrophobic/hydrophilic surfaces of solid materials can be found in different macromolecules. Water bound at the hydrophilic/hydrophobic interfaces can be assigned to several structural types as weakly and strongly associated waters, which can be also weakly or strongly bound to the macromolecules.

Not only the polymer that forms the skeleton of the hydrogel, but also the arms that binding the polymeric chains determine the characteristics of the network of the hydrogel, considering these cross-linking agents also show hydrophilic/hydrophobic moieties. Thus the cross-linking density and the functionality of crosslinker must be taken into account to get a complete representation of hydrogel. For instance it is clear

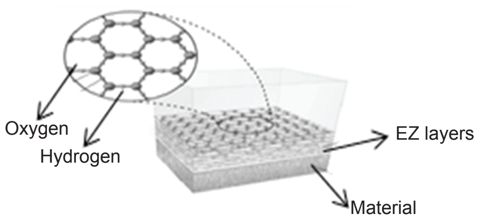

Fig. 6. Liquid crystalline water arrays forming EZ honeycomb structure on a surface (Adapted from Pollack 2013).