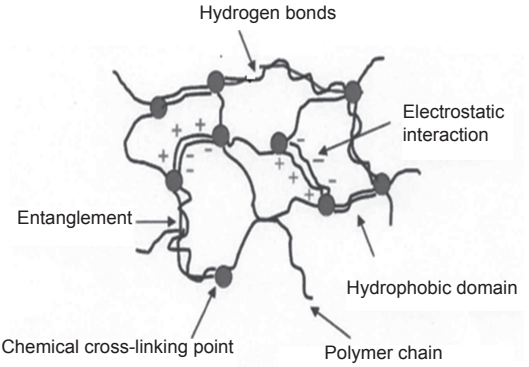

Fig. 1. Schematic representation of hydrogel with different interactions (Adapted from Barbucci 2013).

Hydrophobic interactions have also been exploited to design physical gels. They are generally obtained from multiblock copolymers or graft copolymers. The latter can be composed of a water-soluble polymer backbone, for example, a polysaccharide, to which hydrophobic units are attached, or hydrophobic chains containing water-soluble grafts.

Hydrogen bonding interactions can also be used to form physically gel-like structures. Mixtures of two or more natural polymers can display rheological synergism, meaning that the viscoelastic properties of the polymer blends are more gel-like than those of the constituent polymers measured individually (Gupta et al. 2006). Blends of, for example, gelatin–agar, starch–carboxymethyl cellulose, and hyaluronic acid–methylcelluloses form physically gel-like structures that are injectable. Crystallization of polymers has also been used to form physically gels. When aqueous solutions of poly(vinyl alcohol) (PVA) undergo a freeze–thawing process, a strong and highly elastic gel is formed. Gel formation is ascribed to the formation of PVA crystallites that act as physical sites in the network (Yokoyama et al. 1986) as shown in Fig. 2.

The ubiquitous non-covalent interactions in biological systems are also being used to generate hydrogels with unique, dynamic functions (Mohammed and Murphy 2009). Biological systems are dominated by non-covalent interactions, which can be defined as intermolecular interactions, in which there is no change in either chemical bonding or electron pairing (Kollman 1977). These interactions provide an excellent mechanism for dynamically regulating the assembly and function of biological systems. The formation of coiled-coil aggregates of the terminal domains in near-neutral aqueous solutions triggers the formation of a three-dimensional polymer network, with the polyelectrolyte segment retaining solvent and preventing precipitation of the chain.

In the second case, covalent bonds among the polymer chains are formed. Obviously physical interactions can also be present in the chemical hydrogels. The network shows good mechanical strength and the covalent bonds prevent dissolution of the network in aqueous environment. Chemically crosslinked gels can be obtained by radical polymerization of low-molecular-weight monomers in the presence of a cross-linking agent.