into different classes, such as freezable and non-freezable water, mobile, immobile and clustered water, and free and bound water (Khalid et al. 2002). The classification depends, however, qualitatively and quantitatively, on the experimental technique employed and the analysis of data. The most accredited classification considers that water in the hydrogels exists in three physical states (Fig. 9):

1. The free water which is not intimately bound to the polymer chain and behaves like bulk water, freezing at the usual freezing point (at 0ºC).
2. The intermediate or interstitial water, which is weakly, bound to the polymer chain or interacts weakly with the bound water. It freezes at temperature lower than the usual freezing point.
3. The bound water (non freezing water), which is strongly associated with the hydrophilic segments of polymers and does not freeze at the usual freezing point.

The content of the bound, non-freezing water is affected by the polymer and crosslinker nature as well as their density in the hydrogels. Various hydrogels are reported to have quite different contents of non-freezing water, for example, the 23% non-freezing water in the chitosan–PEO hydrogel (Khalid et al. 2002), the 24–28% non-freezing water in a chitosan hydrogel (Qu et al. 2000), the 35% non-freezing water in the HEMA hydrogels and as high as the 43% non-freezing water in the 2,3-dihydroxy propyl methacrylate (DHPMA) hydrogels (Gates et al. 2003). The molecules of non-freezing water are hydrogen bonded to the hydrophilic groups of the polymer. Therefore, the content of non-freezing water increases with the increase of the ratio of hydrophilic groups (Katime et al. 2000) and decreases with the increase of the ratio of hydrophobic groups (Kim et al. 2003). All that means the hydrogel characteristics

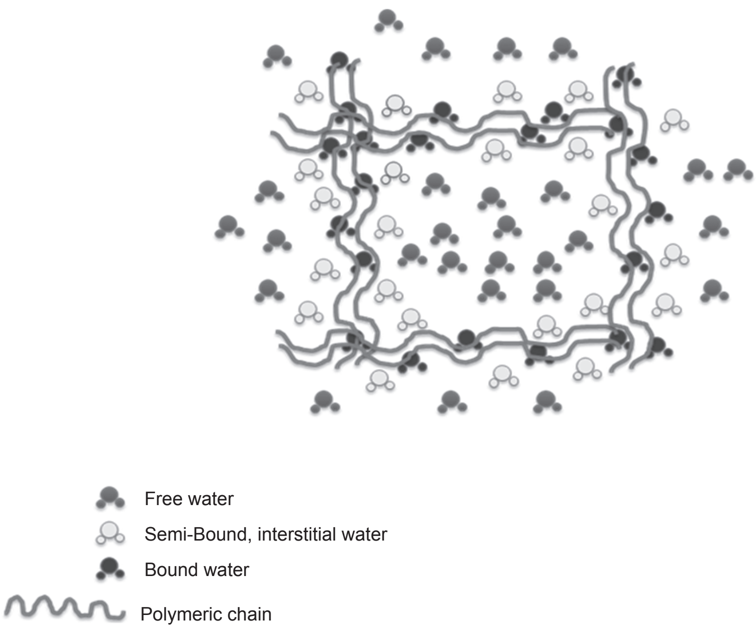

Fig. 9. The three physical states of water in the hydrogels.