

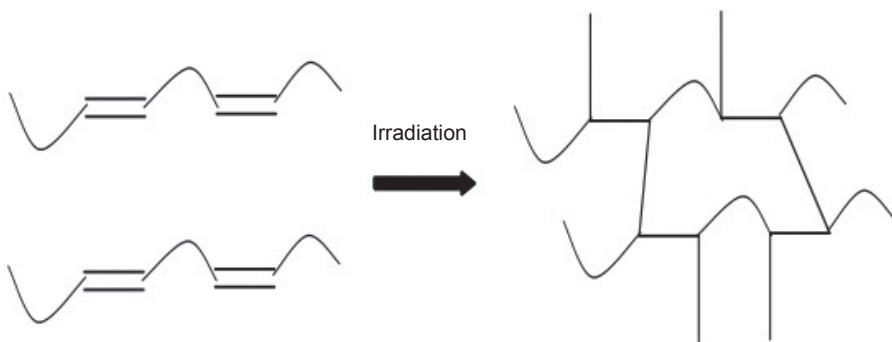
## Hydrogel Synthesis Methods

### *Chemical crosslinked hydrogels*

Chemical crosslinked hydrogels represents a hydrogel class that can change from a liquid state to a gel state by forming new covalent bonds in a polymer network through chemical reactions. These types of hydrogels have typically been used for implantable applications. These types of hydrogels have also been used as injectable devices by forming *in-situ* forming hydrogels. Chemical crosslinked reactions take place by various mechanisms, such as redox reactions, photo-polymerization; click chemistry, Michael reaction, Schiff's base reaction, enzymatic reactions or disulfide-forming reactions. Irrespective of the type of reaction, new covalent bonds formed from these reactions to construct a polymeric three-dimensional network structure in which water can be entrapped and therapeutic agent or living cells can be encapsulated. Each type of reaction involves different synthesis protocol and produces different properties of hydrogels. In this section, some of the main strategies for fabricating injectable chemically cross-linked hydrogels will be addressed.

### *Photo-crosslinking*

Photo-crosslinking usually taken place in the presence of electromagnetic radiation in the visible and UV region. Photo-initiators are interacting with light to generate free radicals, which reacts with photo-curable polymers to initiate crosslinking reaction to form hydrogels (Fig. 2). Broadly, photo-initiation is classified based on the polymerization reaction, which includes radical photo-polymerization by photo-cleavage, radical photo-polymerization by hydrogen abstraction and cationic polymerization. Because of toxicity issues, cationic photo-initiators are generally avoided, as they tend to generate protonic acids (Peiffer et al. 1997; Decker 1987). Photo-crosslinking is a three step-process comprising of initiation, propagation and termination. During the initiation step, the illumination causes the excitation of photo-



**Fig. 2.** Schematic representation of photo-crosslinking of vinyl groups.