with electronic engineering due to the reliance and abundance of water in the hydrogel structures and its negative effect on electronics. The opportunity to significantly advance biosensing platforms to monitor health and electronic signalling components for the nervous system makes research efforts in this area valuable. Peptide-based conducting hydrogel materials have been produced by incorporation of aromatic ligands such as 1,4,5,8-naphthalenetetracarboxylic acid diimide (NDI) at optimal locations. Shao and Parquette developed a transparent NDI hydrogel FmocKK (NDI) which formed β-sheets in aqueous solution driven by hydrophobic π-π interactions of NDI and Fmoc chromophores (Shao and Parquette 2010). Electrostatic repulsions governed by the neighbouring cationic charge of dilysines prevented aggregation and promoted an optimal hydrophobic: hydrophilic balance. The presence of NDI, which can control long-range charge migration, means this hydrogel may have potential applications within bioelectronic devices that source, detect and control light. Electrically-responsive hydrogels are also thought to be of benefit as future artificial muscle fibres replicating the response to electrical signals applied by neurons (Osada et al. 1992), or for tailored drug-delivery in the form of implanted pulsatile subcutaneous implants (Murdan 2003).

Future Perspectives

The development of bioinspired hydrogel materials have accelerated in the past decade however there remain a number of barriers that have to be overcome to ensure their widespread clinical translation. Despite some progress, cost-effective pharmaceutical scale-up of biomolecules, in line with current Good Manufacturing Practice (cGMP) (Fosgerau and Hoffmann 2015). Up-scaling from the laboratory to the industrial setting is a major challenge especially for large protein molecules of hundreds of amino acids and more complicated chemically modified biomolecules (e.g., peptide-sugar-nucleic acid conjugates) (Du et al. 2014). Sequences over 35 amino acids are not currently acknowledge to be economically feasible to mass produce by chemical methods alone (Sato et al. 2006). Recombinant production by transgenic means (bacteria, fungi, animals) is a viable alternative but face challenges related to long lead times, ethical considerations (animals) and efficient production purification of self-assembling molecules which may precipitate during manufacture (Kyle et al. 2009). Despite these challenges there is still a therapeutic appetite for hydrogel biomaterials composed of biomolecular building blocks. Great confidence can be taken from the research advances outlined in this chapter and the clinical translation of self-assembling peptide therapies such as lanreotide (Valery et al. 2003). The potential applications of hydrogel formats are expanding rapidly in the medical field with some of the most exciting recent developments using hydrogels as scaffolds for 3D printing of replacement organs (Bhattacharjee et al. 2015), and to form magnetic-responsive, noodle-like fibres for artificial muscle formation (Li et al. 2015). Such exciting approaches will only reaffirm the importance of hydrogels platforms in advancing future healthcare and biomaterial strategies.