Research project:

Dr. Ghasem R. Bardajee is already co-author of 81 publications in material and polymer chemistry. His research profile deals with the synthesis of a variety of polysaccharide based hydrogels, of which the swelling behavior has been investigated in different conditions. This approach extended to the preparation of hydrogel nanocomposites and especially supermagnetic iron oxide nanocomposite hydrogels by simultaneous in situ formation of iron oxide nanoparticles and cross-linked polymer networks. The drug release behaviors, antibacterial activity and cytotoxicity of the hydrogels has been assessed their possible application in the biomedical field. Furthermore, Dr Ghasem R. Bardajee has reported a facile method for surface modification of water-soluble CdS, CdSe and CdTe quantum dots (QDs) by polysaccharide based biopolymers. The QDs can exhibit good optical properties and stable fluorescence intensity in water after coating with biopolymers.

The reason for the collaboration is the development of a research project that displays good complementarity between his own research project and those of LPPI from UCP. Indeed, almost all the materials synthesized in LPPI are multicomponent so that the final material has the desired properties, often antagonist. Obtaining them is determined by the morphology of the mixture to be homogeneous on a scale of preferably less than one hundred nanometers. However, related compounds are generally thermodynamically incompatible resulting in phase separation mechanisms appropriate to understand and master. Thus, on polymer materials, the interpenetrating polymer network architecture (IPN) is the only possible mode of association of two crosslinked polymers. It corresponds to the combination of crosslinked polymers of which at least one is synthesized in the presence of the other. It is dimensionally stable over time and can optionally have improved properties of resistance to chemical and physical aging. The recently developed IPNs, for various applications, are based on hydrogel (Acta Biomaterialia 7 (2011) 2418–2427; Biomacromolecules 2013, 14 (11), pp 3870–3879; Polymer 62, 2015, 19-27; J of Power Sources 197 (2012) 267– 275; J of Power Sources 274, 2015, 488-495, J Power Sources 274, 2015, 636-644).

Armed with these know-hows, the current project aimed at developing polysaccharide based double networks. Double network is the counterpart of IPN but it is mainly composed of two hydrogel networks. It was first developed by Y. Osada and provides an innovative and universal pass way to fabricate hydrogels with super high toughness comparable to rubbers. The excellent mechanical performances of DN hydrogels originate from the specific combination of two networks with contrasting structures. The first brittle network serves as sacrificial bonds, which breaks into small clusters to efficiently disperse the stress around the crack tip into the surrounding damage zone, while the second ductile polymer chains act as hidden length, which extends extensively to sustain large deformation. This strategy would help at synthesizing polysaccharide based biopolymers with high toughness, which could further be helpful for biological application. So the DN will be synthesized by radical polymerization from alginate –polyacrylamide as former conetnetwork. The second network will be based on poly(acrylamide), poly(acrylic acid) or Poly(2-acrylamido-2-methyl-1-propanesulfonic acid). The first network can be optionally exchange with other polysaccharides such as starch, salep and k-carrageenane. Additional properties will be given to the DN by incorporation of nanoparticles (polymeric or metal such az Fe2O3, Au and ...)

Where the experiments are done:

Polymer Chemistry and Nanomaterials Lab, Payame Noor University

- -samples synthesis,

LPPI, UCP:

- Material's mechanical and thermal characterizations (rheometer, DMA, TGA...)
- Microscopic observation (confocal and electronic)