Phosphate based cross-linking agents for poly(vinyl alcohol): physico-chemical characterization and bio-mineralization

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PVA is a highly hydrophilic, water-soluble polymer with chemical versatility and stability. Its properties have been widely investigated also because of its ability to form physical and chemical hydrogels that have already found use in personal care and biomedical applications, including cosmetics, drug-delivery, cartilage replacement. Despite its biocompatibility and biodegradability, PVA is not commonly used as a load bearing biomaterial *per se,* due to the lack of mechanical integrity in physiological conditions. Thus, several strategies to improve its mechanical properties were investigated so far, including the use of cross-linking agents[1] (such as aldehydes, anhydrides, polycarboxylic acids), freeze-thawing cycles,[2] as well as the integration of organic[3] and inorganic fillers[4] Phospate-based crosslinkers have been recently reported as valuable alternatives to more traditional cross-linking agents[5] thanks to their non-toxicity and to the ability of forming phosphate esters with hydroxyl groups under relatively mild conditions.[6]

In this contribution we present our latest results on the physico-chemical characterization of phosphate-based cross-linked poly(vinyl alcohol) (PVA) hydrogels, in view of their application as biomedical materials.

We investigated the use of sodium trimetaphosphate and hexametaphosphate to produce cross-linked PVA hydrogels, and we characterized the obtained materials in view of their application as bio-mineralizable orthopedic substitutes. The materials have been fully characterized by means of thermal analysis (DSC, TGA), rheology (amplitude/frequency sweep, dynamic mechanical analysis) and microscopy (SEM, AFM). The results demonstrate that materials with different properties could be obtained by the careful control on experimental conditions (*i.e.,* pH, T, reaction time, concentration). In particular, the study is focused on the effect of the different phosphate esters (both in terms of their presence and chemical nature) in the PVA hydrogel. The influence of phopshates on the mineralization properties (evaluated in simulated body fluid at 37°C) was also evaluated, in the attempt of relating the morphology and the amount of the mineral phase to the composition of the cross-linked PVA hydrogels.

Acknowledgements CSGI (Consorzio Interuniversitario per lo Sviluppo dei Sistemi a Grande Interfase) is acknowledged for financial support.

[1] B. Bolto *et al.*, *Prog. Polym. Sci.*, 2009, **34**, 969.
[2] C.M. Hassan, N.A. Peppas, *Biopolymers· PVA Hydrogels, Anionic Polymerisation Nanocomposites*, 2000, 4, 37-65, Springer, Heidelberg, Germany.
[3] M. Roohani *et al*., *Eur. Polym. J.,* 2008,ee ***44***, 2489.
[4] M. Kokabi, M. Sirousazar, Z.M. Hassan, *Eur. Polym. J.,* 2007, ***43***, 773.
[5] G. Leone *et al.*, *J. Mater. Sci. Mater. Med.,* 2010, **21**, 2491
[6] S. Lack *et al*., Carbohydrate Research, 2007, **342** 943.