Study of the Crosslinking of PHEMA Hydrogels by FTIR for Biomedical Applications

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Statement of Purpose: The use of polymeric hydrogels in the biomedical field is rapidly expanding. Within them we can highlight the poly 2 - hydroxy ethyl methacrylate (PHEMA). This is because it is a hydrogel very versatile in the field of medicine, due to its properties of biocompatibility, high hydrophilicity and similarities to the soft tissues of the body. Thus, it can be applied as a contact lens, a device for controlled drug release, implants and artificial articular cartilage. For each application, however, you must satisfy certain end properties and healing mechanism, inherent in the method of polymer synthesis. The objective of this work is, therefore, to understand the influence of the amount of monomer polymerization, 2-hydroxy ethyl methacrylate, in the mechanism of crosslinking of PHEMA hydrogels studied, using the technique of infrared spectroscopy (FTIR), with well-defined objective of application of these hydrogels as a substrate for cell culture.

Methods: 2-hydroxy ethyl methacrylate as monomer of the polymerization reaction (HEMA), diethylene glycol dimethacrylate (DEGDMA) as curing agent, and potassium persulfate (PKS) as termoiniciador were the reagents used in this work, from Sigma-Aldrich (BR), all with content of 99% purity. The samples were prepared in the ratio HEMA / water 100 to 0% w / w compared to HEMA. The initial concentration of DEGDMA and PKS remained constant, respectively, 2% w / w and 1% w / w compared to monomer. The polymerization / crosslinking of the samples was done simultaneously using a thermal source points with 8 mm in diameter, via free radicals. The reaction mechanism was assessed using a spectrophotometer Thermo Scientific Nicolet IR 100 FTIR, resolution 4000 to 400 cm-1 in mode of attenuated total reflectance (ATR).

Results: Changes of the absorbance peak at 1637 cm -1 (C = C stretching) samples with different percentages of HEMA estimated the conversion of vinyl groups of HEMA and DEGDMA in crosslinked samples (figure 1).

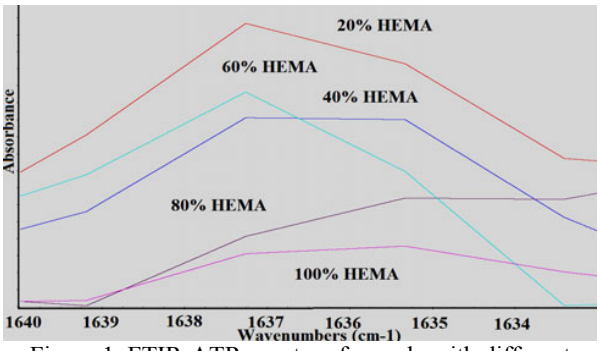

Figure 1. FTIR-ATR spectra of sample with different weight percentage of HEMA

The absorbance peak at 1720 cm-1 (C = O stretching) was used as internal standard to confirm the consumption of C = C bands in HEMA and DEGDMA. It is shown that the intensity of the band near 1635 cm-1, decreases with increasing content of HEMA for samples with 20, 80 and 100% HEMA percent by weight (figure 1). But for the samples crosslinked with 40% and 60 percent by weight of the monomer, there is an inversion of the reaction mechanism, which can be viewed by the increased intensity of the band of the sample 60% percentage by weight of HEMA (figure 2)

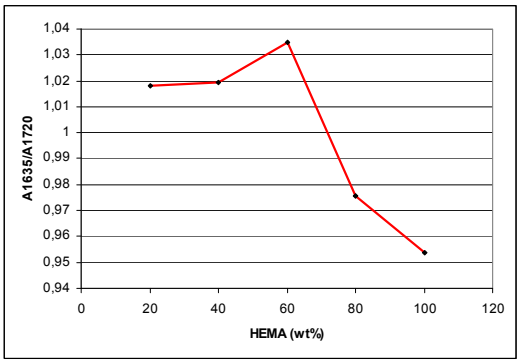

Figure 2. Relative intensity of C=C band to C=O band in FTIR-ATR spectra for samples with different weight percentage HEMA

Conclusions: The spectrum of figure 1 shows that vinyl groups are consumed during the polymerization reaction and curing of HEMA simultaneous. It is seen that the relative intensity of the bands C = C decreases with increase in weight rate HEMA / water. This can be explained by the crosslinking agent DEGDMA. Although this concentration was kept constant at the beginning of the reaction, during the preparation of raw material HEMA may be present DEGDMA as a by-product of the reaction. Thus, insofar as it increases the amount of HEMA, there may be variation in the DEGDMA concentration in reaction medium, which acts as a healer, facilitates networking by reducing the rate of termination of life of free radicals. However, in the concentration of 40 percent to 60% by mass of HEMA the reaction mechanism is changed. When the reaction conversion increases due to higher fraction of DEGDMA, the density of the matrix increases, the monomers are trapped in this and the vinyl groups are prevented from reacting. The diffusional resistance, therefore, becomes at this concentration, the predominant mechanism. (Huang, C-W. J.Wiley, Inc. 1996; 1873-1888). This result is therefore of paramount importance in the interpretation and synthesis of PHEMA substrates for cell culture, and view their final properties.

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