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Biomaterial Based on pHEMA-co-MMA for Articular Cartilage Repairing: Kinetic Reaction Study

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Abstract – The kinetic reaction study is one of the characterizations necessary for cartilage tissue engineering using pHEMA-co-MMA as biomaterial. Mettler Toledo DSC 823e calorimeter was used for thermal analysis, dynamic and isothermal. In first place the dynamic were performed, obtaining the Heating Flow X Time Graph (Fig. 1) at different Heating Rates. After, the isothermal were performed, obtaining the Fractional Conversion (α values) with t at a given Temperature (Fig. 2). With these results we can understand how these co-polymer behave in a thermal way and how it can be used as biomaterial.

The articular cartilage has the function of allow articular bones movement because of the protecting lubrification which also reduces the maximum contact stress on the surfaces, which make charges support without suffer friction and wear. However, when damaged, they show few or none regeneration capacity and can cause articulation degenerative changes [1]. Among the biomaterials, a chemically interesting class is the hydrogels based on 2-hydroxietil metacrylate (HEMA) because of its excellent biocompatibility and high chemical stability [2]. But when they are swollen, show low mechanical resistance. To improve the polymer, the addition of methyl metacrylate (MMA) was done to high mechanical resistance [3].

The kinetic reaction study of the copolymer 2-hydroxietil metacrylate-co-methyl metacrylate (HEMA-co-MMA) was performed in Mettler Toledo DSC 823e calorimeter. A solution containing 3 mL of HEMA 97% (Aldrich) and 0,01g of dibenzoil peroxid (Laporte Organiscs) was prepared as control solution. From this solution, 1.5 mL was taken and added 0,5 mL of MMA 99% (Aldrich). The utilized mass varied from 5 to 10 mg for each test. Dynamic analysis with rates of 2.5°, 5º e 10 ºC/min were done in a temperature var iation from 25℃ to 250℃ for both solutions. After that, Isothermal analysis were done with 80ºC and 90ºC to 20 min for each temperature used for both solutions.

The best properties are achieved when using the appropriate proportions of the reactants. In this condition, the system leads the network structure because reaches the maximum conversion. These curves were analyzed by the Vyazovkin method (Free Kinetics Model). It is possible to determine the α with t at a given temperature and/or dependence α with t at desired heating rate, showing that the maximum conversion is 90%.

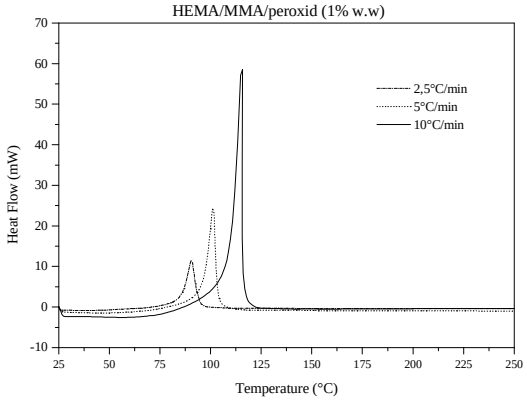

Figure 1: Curves concerning HEMA/MMA/peroxid system for the reaction process with different heating rates at dynamic analysis.

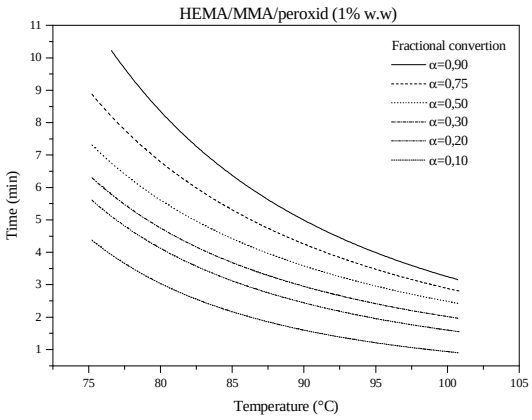

Figure 2: Conversion provided at temperatures of 70 to 105 ℃ in time function at isothermal analysis.

References

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