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Dielectric Characterization of Biopolymer/Poly(ε-Caprolactone) Hydrogels

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The dielectric properties of a series of pure atelocollagen samples and of atelocollagen-based hydrogels long-range cross-linked with bifunctional poly(ε-caprolactone) derivative, or further short-range cross-linked by UV irradiation, were discussed in relation to the cross-linking method, composition, and hierarchical assembly. Three main factors with significant influence on the electrical behavior, frequency, temperature, and moisture content, are analyzed in detail.

Keywords: Biopolymers; Dielectric properties; Multiple cross-linking; Poly(ε-caprolactone)

INTRODUCTION

Hydrogels, especially those based on biopolymers, are materials of high interest due to their applications in biomedical, pharmaceutical, and cosmetics areas. Different characterization techniques have been used to understand their complex behavior, envisaging the development of new materials with appropriate designs for successful industrial implementation. Among them, dielectric spectroscopy has proven to be a very useful tool to study the structure and dynamics of polymeric systems,[1] complemented by dynamic mechanical analysis (DMA) and differential scanning calorimetry (DSC).

The electrical properties of 3-D materials, together with topographical, mechanical, and biochemical properties, are important cues for applications in tissue engineering. They affect both the scaffold function and the quality of cell-scaffold interaction, since all the physiological processes in tissues involve conduction and polarization mechanisms.[2]

In this context, the aim of the present work is to use dielectric spectroscopy to analyze earlier developed hydrogels (atelocollagen (AteCol) and dimethylsylandiol hyaluronate (DMSHA)) obtained by combining different stabilization approaches, i.e., long-range cross-linking with a reactive poly(ε-caprolactone) derivative and short-range cross-linking by UV irradiation or carbodiimide chemistry.[3,4] They benefit from the combination of biopolymers, which have

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