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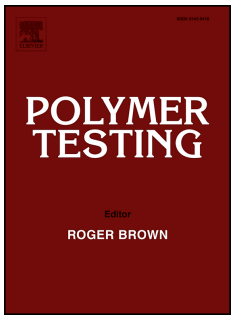

TD-NMR analysis of structural evolution in PVDF induced by stress relaxation

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TD-NMR analysis of structural evolution in PVDF induced by stress relaxation

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Abstract

Poly(vinylidene fluoride) was relaxed at different temperatures (23, 80 and 120 ºC) and strains (3.5, 7 and 10%) during 24 h. The material, as processed and all relaxed conditions, was characterized by tensile tests and time-domain nuclear magnetic resonance (TD-NMR). Tensile tests after stress relaxation showed a huge drop in the elastic modulus, varying from 30% to 45% compared to the as processed material. The TD-NMR technique allowed to correlate the variation of the mechanical property with the evolution of the structure inside the material, namely, decrease of crystalline fraction and increase of constrained amorphous region due to the stress relaxation. However, the free amorphous fraction did not undergo a significant change. The structure evolution described above occurred in nanoscale, even for the smallest strain (3.5%) and the lowest temperature (23 ºC) tested here, while no visual change was noticed, even for the extreme conditions (10% and 120 ºC).

Keywords: Structural evolution, stress relaxation, TD-NMR, poly(vinylidene fluoride).

1. Introduction

Poly(vinylidene fluoride) (or PVDF) is a semicrystalline engineering polymer consisting of long molecular chains formed by a repetition of the molecular unit CH_2-CF_2, and alternating crystalline and amorphous regions [1]. The multiple covalent carbon-fluorine bonds give to this polymer excellent thermal stability and chemical resistance, and high mechanical properties [2-6]. These characteristics favor its use in structural applications and in chemically aggressive environments, such as in demanding flexible lines in the offshore industry, where it has to stand different chemicals up to 130 ºC [7]. PVDF can present five different crystal structures, identified as α, β, γ,