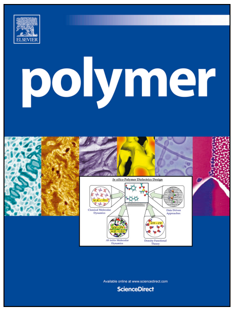

Acoustic emission from the initiation of plastic deformation of Polyethylenes during tensile tests

N. Casiez, S. Deschanel, T. Monnier, O. Lame

PII: S0032-3861(14)00850-7

DOI: 10.1016/j.polymer.2014.09.044

Reference: JPOL 17286

To appear in: *Polymer*

Received Date: 17 July 2014

Revised Date: 15 September 2014

Accepted Date: 17 September 2014

Please cite this article as: Casiez N, Deschanel S, Monnier T, Lame O, Acoustic emission from the initiation of plastic deformation of Polyethylenes during tensile tests, *Polymer* (2014), doi: 10.1016/j.polymer.2014.09.044.

Acoustic emission from the initiation of plastic deformation of Polyethylenes during tensile tests

N. Casiez,[†] S. Deschanel,[,†] T. Monnier,[‡] and O. Lame,[†]*

[†]Université de Lyon, MATEIS, UMR 5510, INSA de Lyon, 69621, Villeurbanne, France
[‡]Université de Lyon, LVA, EA 677, INSA de Lyon, 69621, Villeurbanne, France
*Corresponding author: Tel (+33) 47-243-8184; Fax (+33) 47-243-8539;
e-mail: stephanie.deschanel@insa-lyon.fr

ABSTRACT: The acoustic emission (AE) technique has been used in the aim to detect and to observe the initiation of plasticity and damage of several Polyethylenes (PE) during tensile tests. The detection of acoustic signals originating from the deformation of the material is challenging since PE samples strongly attenuate ultrasonic waves. A weak acoustic activity has been recorded during the tests. The use of two types of PE specimens and two methodologies based on the elimination and the discrimination of spurious sources has shown that most of the AE signals truly originate from the plastic deformation of materials. We also observed that the acoustic activity increases with strain rate. Besides, some AE signals ~~events~~ are located along the specimen length ~~localized~~ during tensile tests at high strain rate. The acoustic activity increases strongly with the crystallinity. Micro-cavities, formed before the yield point of PE samples with high crystallinity in particular, likely initiate the release of acoustic energy. In addition, some signals are collected on PE samples, which do not exhibit a formation of cavitation. Hence, the shearing of crystallites and/or the fragmentation of crystalline lamellae may also be a source of the release of acoustic energies.

Keywords: Acoustic emission, Polyethylene, Plastic deformation

1. Introduction

The plastic deformation and damage of semi-crystalline polymers in tensile tests have been widely studied [1-~~12~~13]. However, the *in situ* determination of the initiation of micro-structural plastic events such as shearing of crystallites or cavitation remains problematic and requires complex devices such as SAXS or tomography [9-15]. As an *in situ* and convenient technique, acoustic emission (AE) is often used to analyze plastic deformation and damage of materials such as metals, ceramics and composites [16-18]. AE is defined as “the class of phenomena whereby transient elastic waves are generated by the rapid release of energy from localized sources within a material, or the transient elastic waves so generated” (ASTM 1982). The plastic deformation and damage of glassy polymers have been studied with the AE technique [19-22]. Recently, Ronkay et al. [22] recorded the acoustic activity emitted from Polyethylene terephthalate (PET) during tensile tests. The authors attribute the signals to the formation of cavities, which appear with the neck propagation. However, few studies investigated the plastic deformation of pure semi-crystalline polymers above their glass transition temperature with this technique, as they are often thought to be too attenuative. Nevertheless, Bohse [23] observed a very weak acoustic activity during the plastic deformation of high-density Polyethylene (HDPE) and Polypropylene (PP) during tensile tests. Qian et al. [24] recorded few AE signals during the deformation of a large range of polymers including semi-crystalline polymers. Unfortunately, these experimental tests and analysis are insufficient to conclude about the origin of AE signals. For instance, it has not yet been possible to localize AE sources ~~record AE events localized~~ because only one sensor was used for the acquisition of the signals. Therefore, one could wonder if the AE signals recorded under these circumstances are only artifacts. However, it is interesting to note that this technique was