



17th International Conference on Advanced
Computational Engineering and Experimenting
BARCELONA, 1-5 July 2024
www.acex-conference.com

ABSTRACT:

Cyclic Indentation of Polymers: A Way to Characterise Viscoelasticity by Nanoindentation

O. Smerdova

Institut Pprime (ISAE-ENSMA, CNRS, University of Poitiers),
1 Avenue Clement Ader, Chasseneuil du Poitou, 86360, FRANCE

Nanoindentation has a number of advantages compared to traditional macroscopic mechanical tests. For instance, it is irreplaceable for in-situ mechanical characterisation of separate phases of heterogeneous materials or materials with gradients, without any underlying homogenisation model. Unfortunately, contact models usually used to analyse nanoindentation data give simple analytical solutions only for elastic and elasto-plastic materials. In the case of time-dependent materials, this is not enough. One possible way to use the nanoindentation data on polymers is to combine experimental and numerical procedures and use inverse analysis to identify parameters of a given constitutive law. However, it is difficult to obtain a unique set of parameters of a viscoelastic law from nanoindentation, no matter the protocol used [1].

It was shown experimentally on a series of polymers [2] that the cyclic indentation response carries rich information for characterisation of a viscoelastic material at several time scales. In this presentation, a simulated response of a viscoelastic material to the cyclic indentation loading will be studied over the full time range of relaxation processes. The use of elastic and elasto-plastic models for indentation of a viscoelastic material will be discussed. Finally, the experimental data will be used to obtain the relaxation modulus of the HDPE polymer.

[1] M.C. Barick, Y. Gaillard, A. Lejeune, F. Amiot and F. Richard, Int J Solids & Str, 202 (2020).

[2] O. Smerdova, M. Pecora, M. Gigliotti, J Mat Research, 34 (2019).