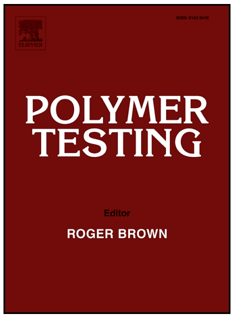
# Accepted Manuscript

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PII: S0142-9418(18)30931-0

DOI: 10.1016/j.polymertesting.2018.07.017

Reference: POTE 5550

To appear in: *Polymer Testing*

Received Date: 13 June 2018

Accepted Date: 23 July 2018

Please cite this article as: S. Castagnet, D. Mellier, A. Nait-Ali, G. Benoit, In-situ X-ray computed tomography of decompression failure in a rubber exposed to high-pressure gas, *Polymer Testing* (2018), doi: 10.1016/j.polymertesting.2018.07.017.

Test Method

# In-situ X-ray computed tomography of decompression failure in a rubber exposed to high-pressure gas

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**ABSTRACT**

Cavitation is a damage process often observed during or after pressure release in polymers exposed to high-pressure diffusive gases. Only a few characterizations of the phenomenon have been reported in the literature, all of them being based on 2D pictures of the sample taken after removal from the pressure chamber or, more recently, inside the chamber during pressure release. This study displays the first time-resolved 3D imaging of decompression failure in high-pressure gas exposed polymers, obtained from in-situ X-ray computed tomography. New data were provided about the out-of-plane shape and volume distribution of cavities. It allowed rigorous estimation of a Morphological Representative Volume Element for the cavity field. The bias resulting from the former 2D-projection methods could be discussed.

**KEYWORDS:** EPDM; Hydrogen; cavitation; Representative Volume Element (RVE); cavity field

## 1. INTRODUCTION

Rubbers exposed to a high-pressure diffusive gas sometimes undergo cavitation or cracking during pressure release. This decompression-enhanced damage process occurs when the gas cannot desorb out of the polymer fast enough and locally expands. It has often been referred to as explosive decompression failure as most pioneer works were conducted with very fast decompression rates [1]. However, it may also occur under moderate or even slow pressure release rates, and exhibit rather slow growth kinetics.

Decompression failure was reported in the literature a few decades ago in various gas-polymer systems [2-8]. It has not been that much investigated so far, especially in hydrogen. Interest for damage resistance of high-pressure hydrogen-exposed polymers was renewed about ten years ago, when hydrogen started to be considered as a new potential energy carrier. Since decompression failure may affect permeation properties and mechanical resistance, it is a major concern for industrial components designed for fuel cell vehicles and hydrogen charge stations. A better understanding of damage mechanisms is crucial to improve the design of components and the formulation of hydrogen-exposed rubbers. It faces strong limitations, among which is hydrogen manipulation in in-situ experiments. Only