

Surface Analysis of Polymers using Helium Ion Microscopy Coupled with Secondary Ion Mass Spectrometry (HIM-SIMS)

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Polyolefins such as polypropylene (PP), polyethylene (PE), and their copolymers are important industrial materials, used in numerous applications, including oils, tires, fibers, and films. In many of these, chemistry and structure of the materials and their blends can play a crucial role on material performance. Previous studies aimed at distinguishing PP and PE [1-3], and correlating chemistry to morphology have been difficult and required measurements on multiple instruments. In this work, we utilize a helium ion microscope (HIM) equipped with a magnetic sector secondary ion mass spectrometer (SIMS) [4] to differentiate between PE, PP, and their blends *in situ*; offering both chemical and physical information on these polymers.

The HIM is based on a gas field ionization source operating with helium or neon gas and offers a straightforward approach to investigating the structure of various highly insulating samples without the use of a conductive coating [5]. Moreover, the recent incorporation of SIMS analytical capability to the HIM, allows correlative imaging using secondary electrons (SE) with the co-registered chemical information obtained from the SIMS [6].

Here, we demonstrate the HIM-SIMS to quantitatively differentiate between PE and PP, and their copolymer blends. We illustrate the detection, choice, and analysis of specific polymer fragments that allow us to distinguish between PE and PP (see example in Figure 1). Furthermore, we explore the influence of sample charging, depth profiling, as well as the field of view effect during the analysis. Additionally, the capability to correlate chemical and structural information of the polymer from the identical regions will be shown and discussed (see example in Figure 2) [7].

References:

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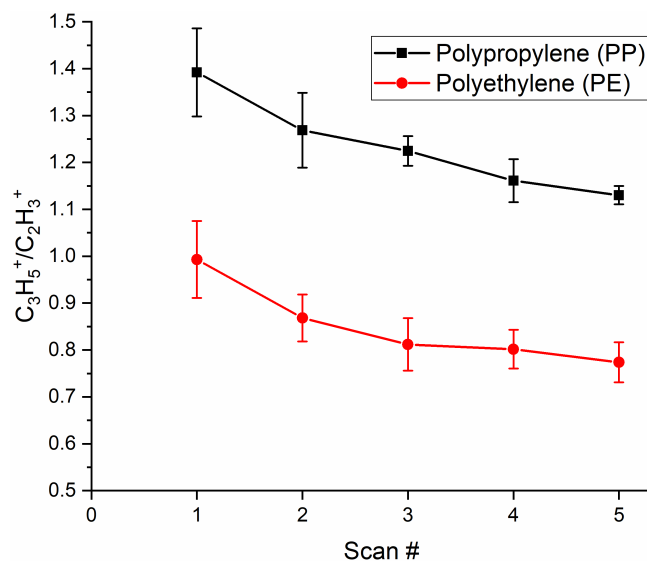


Figure 1. Plot of the relative intensity of $C_3H_5^+$ fragment compared to $C_2H_3^+$ fragment as a function of HIM-SIMS scans highlighting differentiation between PE and PP. Each point is an average of three measurements. Lines connecting the data points are for eye guidance only.

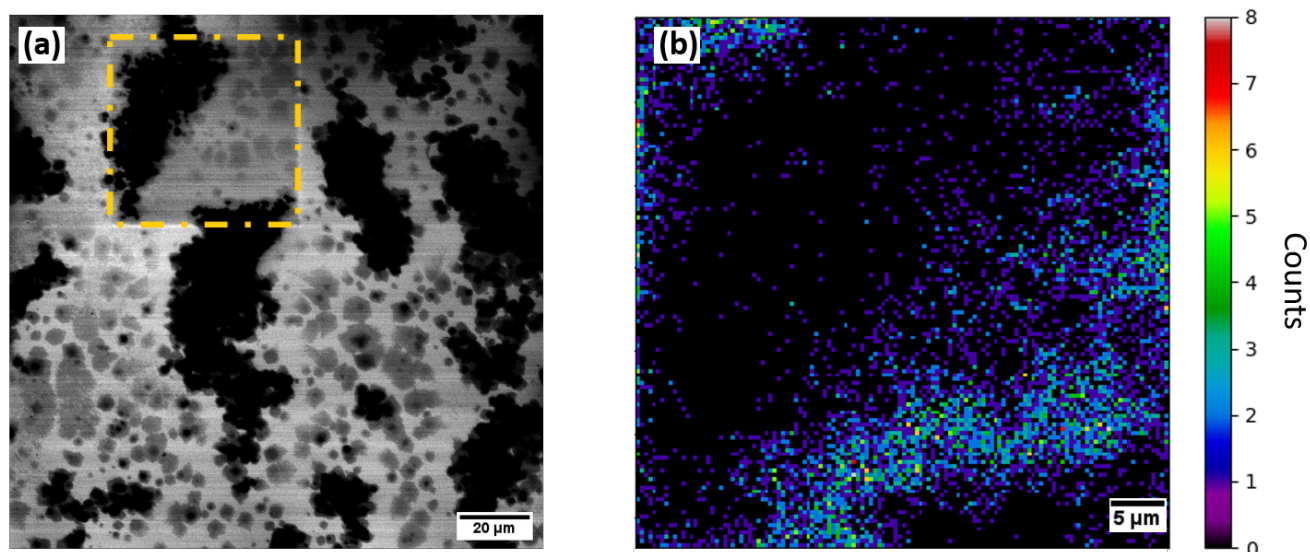


Figure 2. (a) SE image of PE obtained using HIM. (b) Chemical image of the $C_2H_3^+$ distribution in the area indicated in (a) obtained using HIM-SIMS.