Spatial characterisation of PES/PVP based membranes by FT-IR

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Introduction

The requirements for membranes have risen over the past few years. One common material for the membrane production is polyethersulfone (PES), modified with poly(N-vinyl pyrrolidone) (PVP) to increase the hydrophilicity. Despite this material is characterized by a good resistance against attacks by various chemical agents, often the assesment of changes in the membranes´ cross sections is requested. One method to get such results are FT-IR (Fourier transform infrared) maps of the main components. Especially in case of multilayered membranes spatially resolved measurements of the chemically induced changes across the membrane are required.

Methodology and results

For the investigation a Hyperion 3000 FT-IR microscope coupled with a Tensor 27 spectrometer (Bruker, Billerice, USA) were used. To obtain chemical maps both the macro-ATR (attenuated total reflectance) mode and the transmission mode were used. The former proved to be not applicable, because the pressure of the crystal on the sample surface caused a strong deformation of the sample, see Fig. 2. For the measurement in transmission mode 20 µm semi thin slices from membranes embedded in EpoHeat® were used. Therewith it was possible to obtain the distribution of the two main components across the cross-section of various membrane types and the chemically induced changes due to a treatment with bleach solutions, see Fig. 3 – Fig. 6. To compensate the IR signal changes due to the variations of the membrane content per volume unit caused by the porosity of the membranes, the PVP/PES ratio got used in the maps, see e.g. Fig. 3 c).

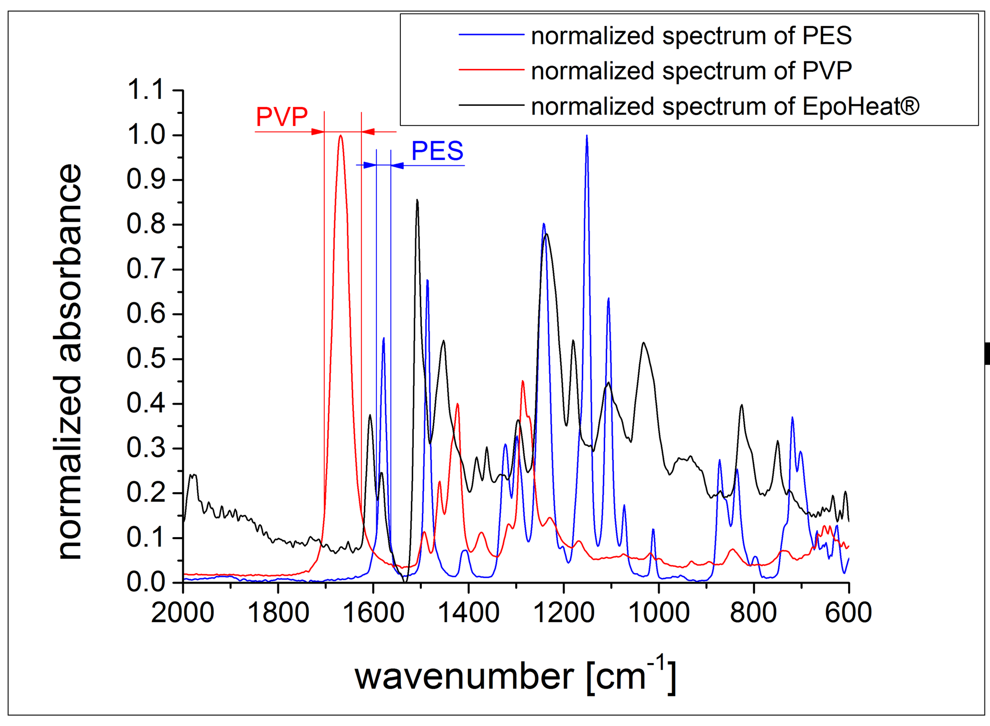
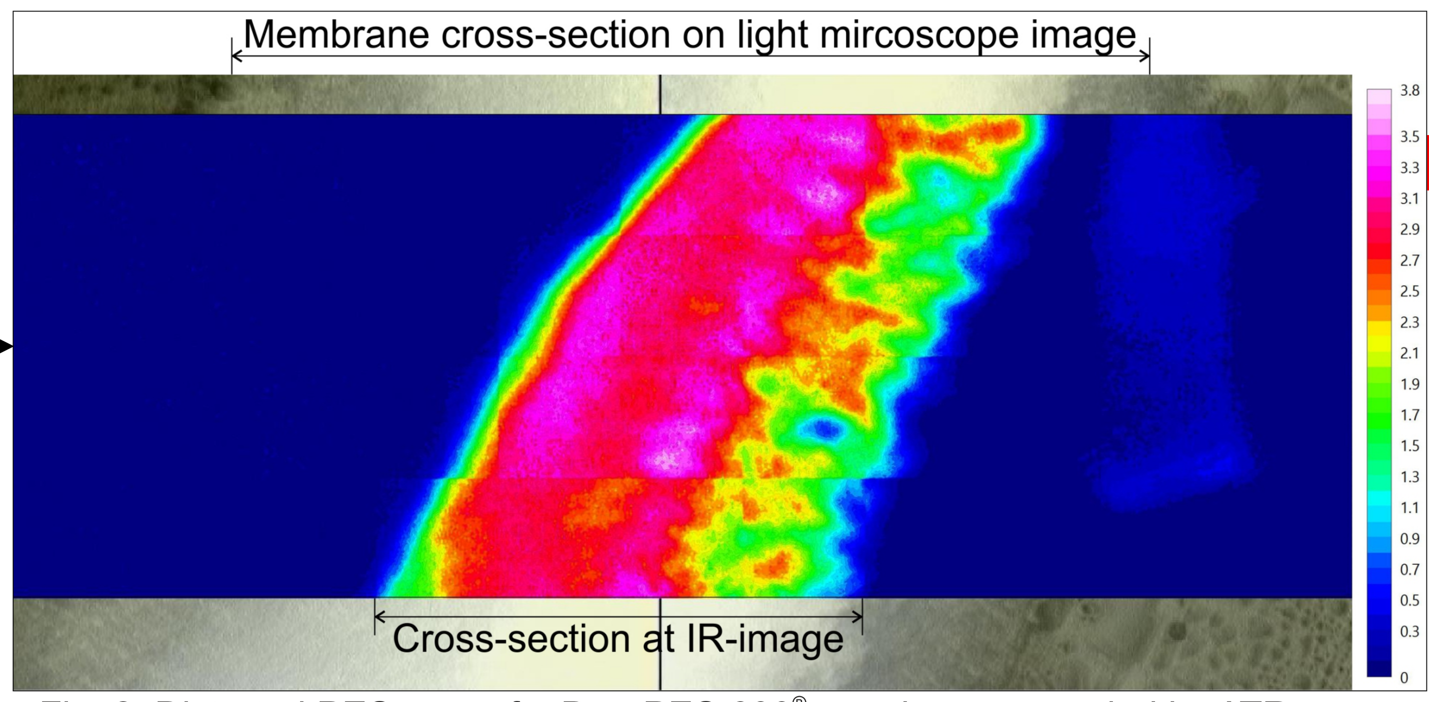


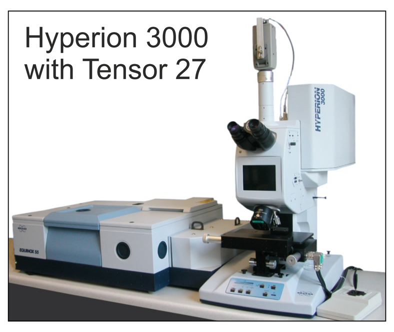
Fig. 1: IR spectra of pure PES and PVP and the used resin EpoHeat®; the IR band ranges used for peak integration to obtain maps of the two main components are marked in the corresponding spectra. To obtain better accuracy the integration of the respective peaks will be improved, using a better peak adjustment routine which will be programmed in MATLAB®.

Chemical map by IR macro ATR imaging



Not applicable because of a strong deformation of the embedded membrane caused by the pressure of the ATR-macro crystal on the sample surface.

Fig. 2: Distorted PES map of a DuraPES 600® membrane recorded by ATR-macro imaging with a germanium crystal; in background: light microscopic image.



Chemical map by IR transmission imaging

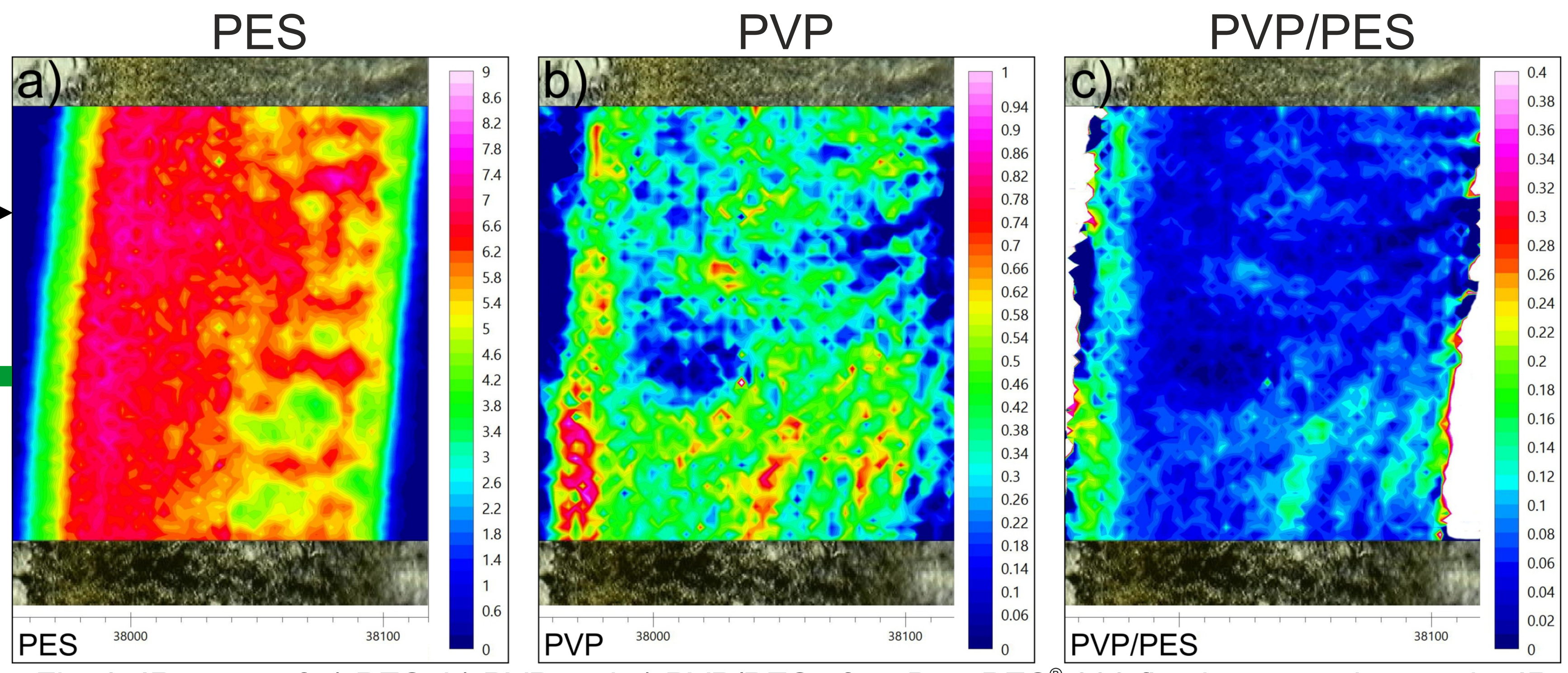
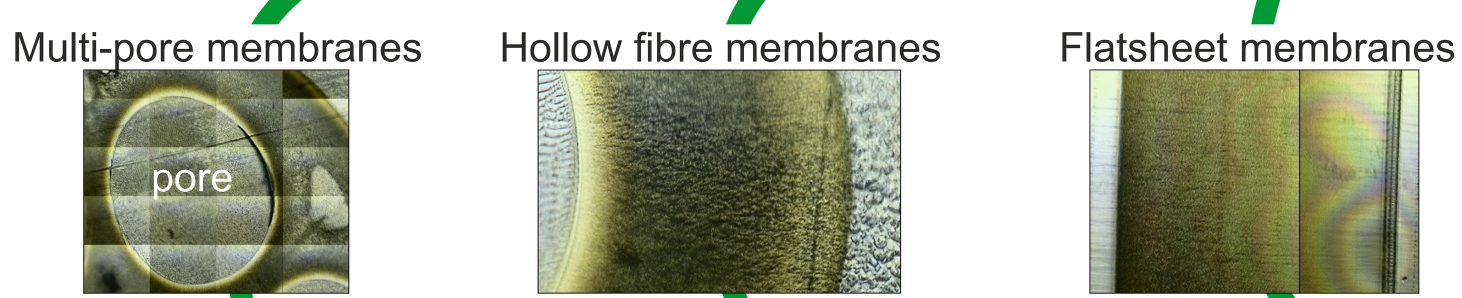


Fig. 3: IR maps of a) PES, b) PVP and c) PVP/PES of an DuraPES® 600 flatsheet membrane; the IR intensity variation due to porosity can be seen at the PES map (filtration layer at the left hand side).



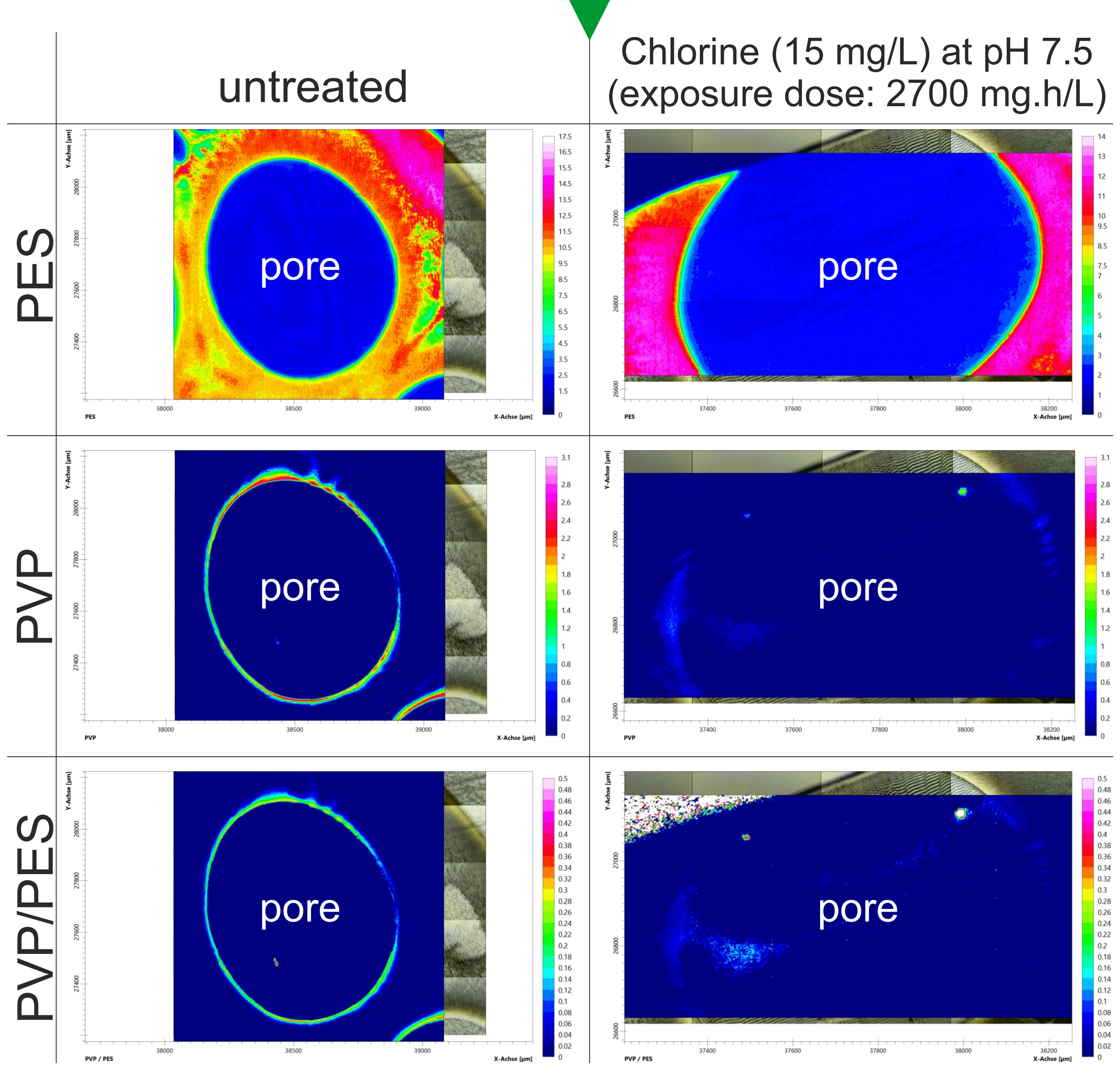


Fig. 4: IR transmission maps of the main components of an untreated and NaClO treated multi-pore membrane.

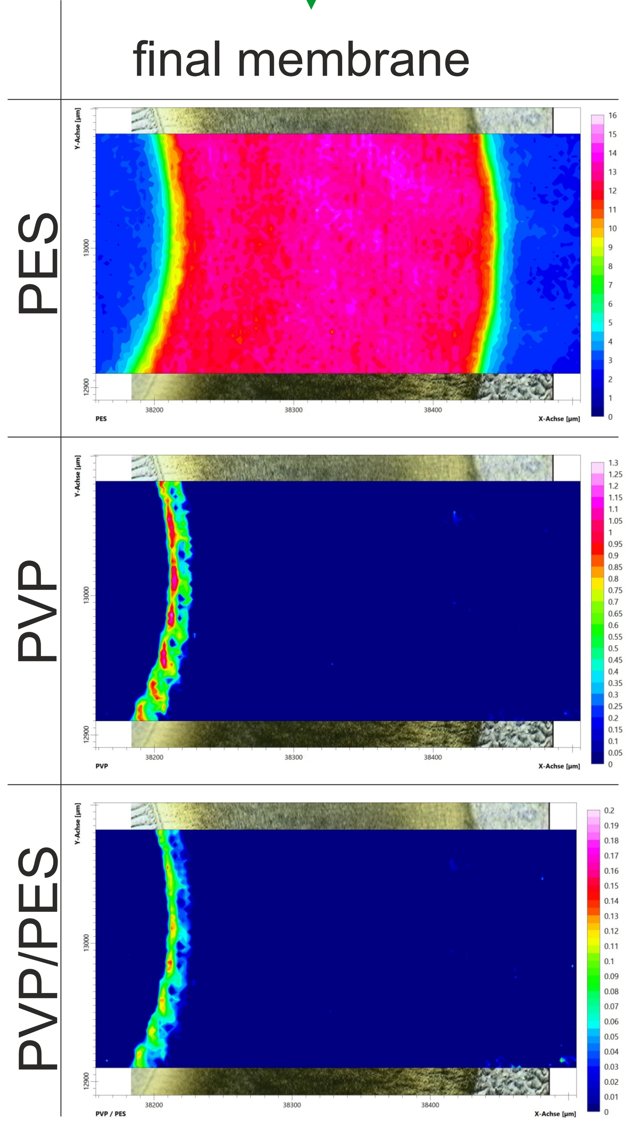


Fig. 5: IR maps of a hollow fibre membrane in transmission mode.

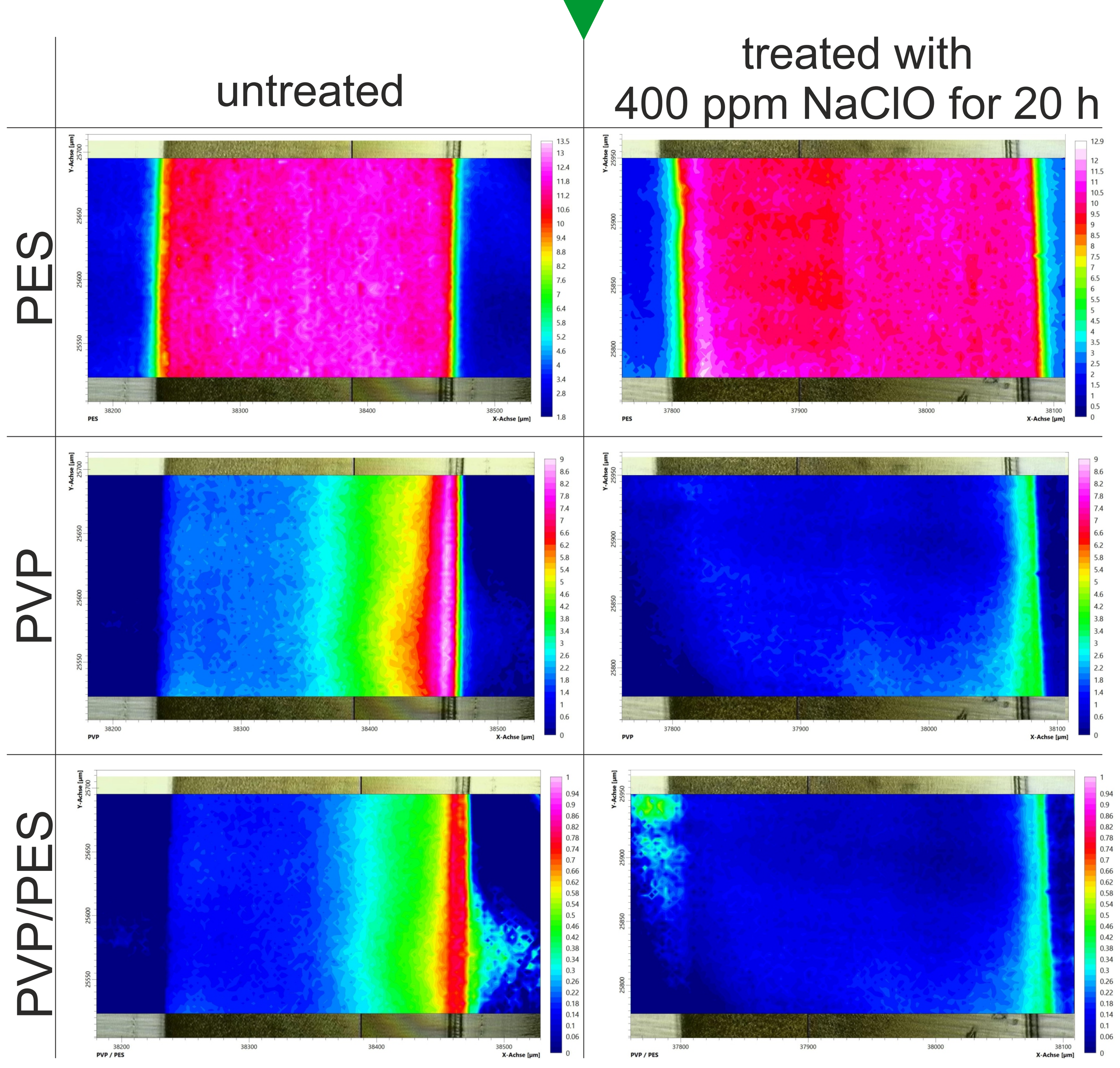


Fig. 6: Maps of both an untreated and NaClO treated flatsheet membrane. The slight mismatch of the light- and IR images at the treated membrane is due to the serial imaging.

Acknowledgements

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