Hydration Structure of Intermediate Water in Medical Polymers

Shigeaki Morita
Department of Engineering Science, Osaka Electro-Communication University, Japan

Summary: Water structure in blood-compatible polymers at the biointerfaces was investigated using in situ attenuated total reflection infrared (ATR-IR) spectroscopy. Hydration structure of intermediate water interacting with the bioinert polymer chain was revealed from the spectroscopic analysis.

e-mail address: smorita@isc.osakac.ac.jp

Introduction: Three different types of hydrating water, i.e., non-freezing water, freezing bound water (or intermediate water) and freezing water, have been found in artificial anti-thrombogenic polymers as well as natural biopolymers using differential scanning calorimetry.[1] In order to elucidate hydration structures of these characteristic water in medical polymers, ATR-IR spectroscopy using an original flow cell was applied as shown in Figure 1.[2,3] Obtained spectra were analyzed by means of numerical computations such as chemometrics, two-dimensional correlation spectroscopy and quantum chemical calculations.[4,5]

Methods: A polymer film was prepared on a flat surface of an IR transparent prism by solvent casting. Time-dependent ATR-IR spectra during a sorption process of water vapor or liquid water were measured using the flow cell.

Results and Discussion: Figure 2 shows time-dependent ATR-IR spectra during a sorption process of liquid water into poly(2-methoxyethyl methacrylate) (PMEA). Increase of the O-H stretching band around 3600-3000 cm^{-1} assigned to hydrating water was observed with spectral shape variation. This represents different hydration structure to the polymer chain at each time. Spectral shape variation in the fingerprint region below 17000 cm^{-1} arising from the polymer chain was also observed, implying change in hydrated functional groups in the chain. Hydration structures in PMEA and related medical polymers will be discussed in detail.

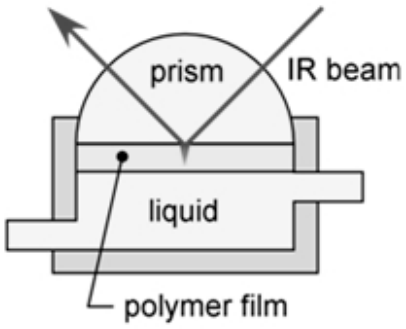

Figure 1. Schematic illustration of the in situ ATR-IR cell.

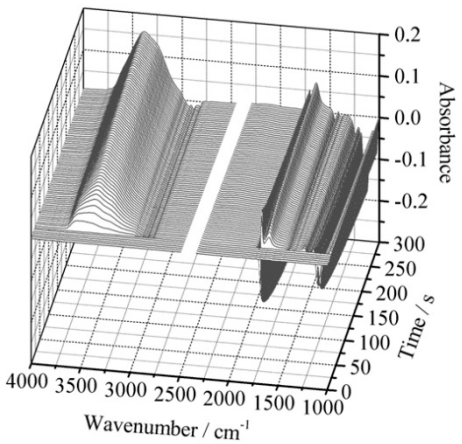

Figure 2. Time-dependent ATR-IR spectra during a sorption process of liquid water into a PMEA film.

References:

1. M. Tanaka, T. Hayashi, S. Morita, Polymer Journal, 45, 701-710, 2013
2. S. Morita, M. Tanaka, Y. Ozaki, Langmuir, 23, 3750-3761, 2007
3. S. Morita, M. Tanaka, Langmuir, 30, 10698–10703, 2014
4. A. Tanabe, S. Morita, M. Tanaka, Y. Ozaki, Applied Spectroscopy, 62, 46-50, 2008
5. S. Morita, M. Tanaka, I. Noda, Y. Ozaki, Applied Spectroscopy, 61, 867-872, 2007