Diffusion Study for pH-sensitive Biopolymers using NMR Microscopy

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Purpose: This study is focused on the dependence of self diffusion coefficienct on the pH changes of pH-sensitive biopolymers without any bulk flow.

Materials and Method: NMR Microscopy has been performed on a 2T home-built MRI system for the study of pH-sensitive biopolymers. Diffusion information was obtained from image intensity attenuation by varying the strength of the frequency encoding gradient, which changes the size of a pixel on each image. Firstly, self diffusion coefficients have been measured for the three solution samples such as DMSO-dimethyl sulfoxide, distilled water, and acetone to confirm the method utilized for the present study. Secondly, the measurements of self diffusion coefficients were made for pH-sensitive polymers. Swelling changes have also been observed by using both time dependent 2D MR images and time dependent optical images of the polymer specimens.

Results: The measured values of self diffusion coefficients for the three solution specimens (DMSO, distilled water, and acetone) are 1.86 ± 0.68, 2.88 ± 0.51, and 5.42 ± 0.34 in the unit of $\times 10^{-5}$ cm^2/s, respectively. No considerable differences have been observed from the time dependent MR images (without diffusion weighting) as well as from the optical images obtained for the pH-sensitive polymer specimens. All of the three polymer specimens were utilized to produce their diffusion coefficients both in a pH-7 solution and in a pH-2 solution. Although two specimens did not provide any noticeable changes in their corresponding diffusion coefficients, one of the three polymer specimens produced considerable changes in self diffusion coefficients: the value was varied from 1.35×10^{-5} cm^2/s in a pH-7 solution to 9.67×10^{-5} cm^2/s in a pH-2 solution.

Conclusion: In the characterization of biopolymers, diffusion weighted MR images provided the valuable information which normal time dependent images can not produce. Diffusion measurements using NMR Microscopy can be one of the important trials which should be performed for the characterization of many pH-biopolymers.