Probing the Molecular Origin of the Viscosity of Hyaluronic Acid Solutions by 2D-IR Spectroscopy

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We use 2D-IR spectroscopy to study the spectral diffusion dynamics of the carbonyl vibrations of hyaluronic acid in highly viscous solutions. These measurements will provide insight into the molecular origin of the viscosity of these solutions.

Hyaluronic acid is one of the main components of the extra-cellular matrix and of articular cartilage, where it is responsible for the binding of water [1]. The high viscoelastic nature of hyaluronic acid provides resilience to cartilage, allowing it to withstand considerable stresses. The molecular origin of the viscoelasticity of hyaluronic acid is, however, not well understood. Interestingly, the viscosity of hyaluronic acid strongly depends on the

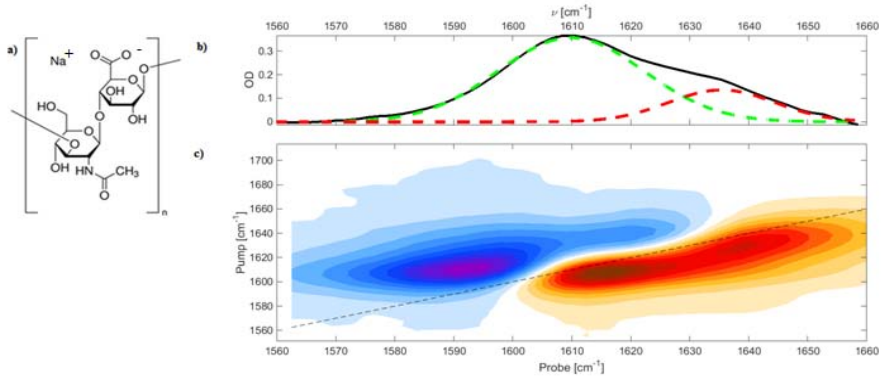

Fig. 1: (a) Structure sodium salt of hyaluronic acid. (b) The experimental linear spectrum of a solution of hyaluronic acid at a concentration of 10 mg/ml in D_2O (black line) and fitted peaks. Dashed green and the red fitted Gaussians represent the COO^- anti-symmetric stretching and the amide I vibrations, respectively and (c) Measured 2D-IR spectrum of a solution of hyaluronic acid at a concentration of 10 mg/ml in D_2O. The population time is 0.3 ps.

concentration of hyaluronic acid and on the pH [2,3]. It has been suggested that the hydrogen-bonding interactions between different hyaluronic acid molecules lie at the origin of the viscosity of these solutions.

Here we use 2D-IR spectroscopy of the different carbonyl modes of hyaluronic acid to characterize the hydrogen-bond fluctuations in these solutions (Fig.1) and we provide a progress report on our results.

[1] R. Servaty *et al.*, International Journal of Biological Macromolecules, **28,** 121 (2001)
[2] I.Gatei *et al.*, Biomacromolecules **6**, 1 (2005)
[3] A.Maleki *et al.*, Macromol.Symp, **274**, 131 (2008)