Broadband Rheology of Hydroxyethyl Cellulose Water Solutions

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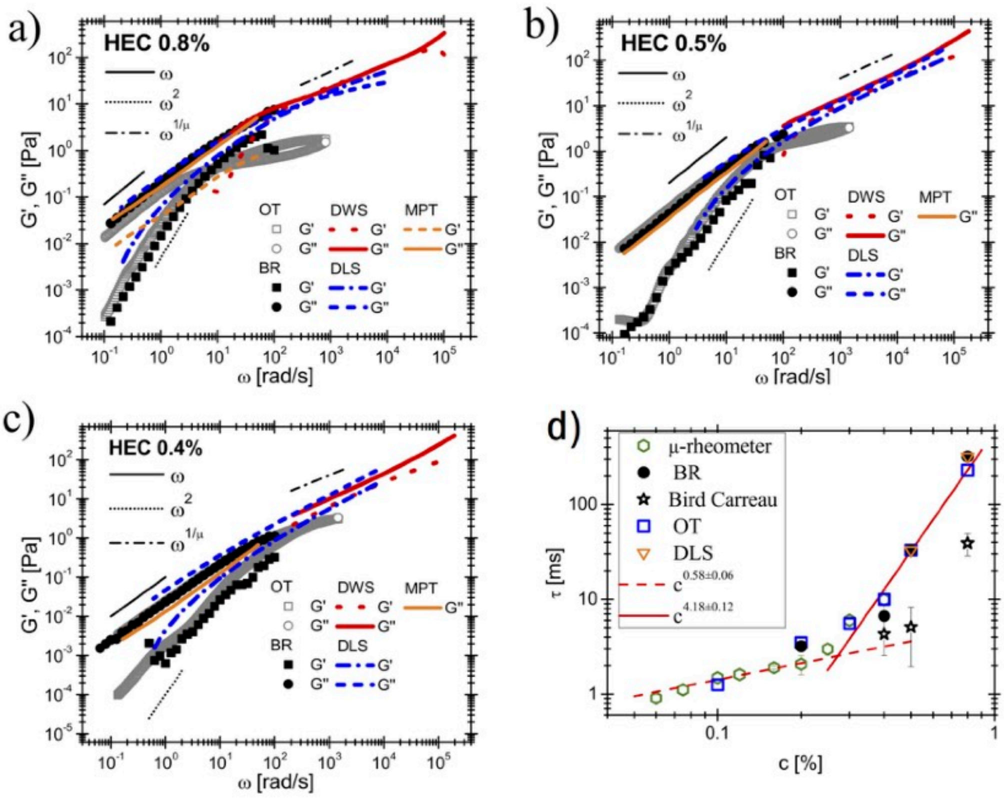
We present new insights related to a debate on the morphological structure of hydroxyethyl cellulose (HEC) molecules when dissolved in water, i.e., whether HEC adopts a linear-flexible or a rod-like fibrillar configuration. We have employed “seven” rheological techniques to explore the viscoelastic properties of HEC solutions at different time and length scales. This work demonstrates an excellent convergence between various rheological techniques over a broad range of frequencies and concentrations, allowing us to derive microstructural information for aqueous HEC solutions without the use of complex optical imaging techniques. We find that when dissolved in water unmodified HEC behaves like a linear uncharged polymer, with an entangled mass concentration of c_e = 0.3 wt%. Moreover, for the first time we provide the concentration scaling laws (across c_e) for the longest relaxation time λ of HEC solutions, obtained from direct readings and not inferred from fitting procedures of fluids shear flow curves.

Reference:
Del Giudice et al., Macromolecules 50, 2951-2963, 2017



a)Comparison between the HEC solutions’ linear viscoelastic moduli versus frequency measured with conventional rotational rheometer (BR), with optical tweezers (OT), Diffusive wave spectroscopy (DWS), Dynamic light scattering (DLS) and multiple particle tracking (MPT), for HEC solutions having concentrations of (a) 0.8, (b) 0.5, and (c) 0.4 wt%. The lines are guides for the theoretical predictions. d) Comparison between the HEC solutions’ longest shear relaxation time λ, directly measured with a μ-rheometer and those educed from viscoelastic moduli measured by means of a rotational rheometer, dynamic light scattering and optical tweezers. The concentration c is expressed in wt%. Lines are the concentration scaling laws of λ, as described in the text.