



Technical note: correlation between Rheolaser MASTER and conventional methods

Introduction

Passive microrheology studies the viscoelastic properties of samples by studying the nanometric movement of particles due to Brownian motion. The movement, or more precisely the displacement of the particles, is directly related to the viscoelastic properties, such as elasticity and viscosity.

This work shows that under controlled conditions, viscosities measured with passive microrheology are in good agreement with those measured with conventional rheology.

IMPORTANT REMARK:

Controlled conditions are required to convert the results into “absolute” macroscopic viscosity values (in Pa.s, or cP):

- Known particle size, and size-distribution
- Homogeneity at the micro-scale
- Equilibrium of the sample

Method

Each MSD curve is related to the viscoelastic properties at the corresponding time or temperature. Linear lines indicate a Newtonian behavior whereas MSD curves with a plateau are the signature for viscoelasticity.

The MSD curves can be interpreted in terms of Elasticity Index (EI) and Macroscopic Viscosity Index (MVI). The higher those indices are, the higher are elasticity and viscosity. The MVI can then be “converted” to a macroscopic viscosity value, as it is proportional to the inverse of the diffusion coefficient.

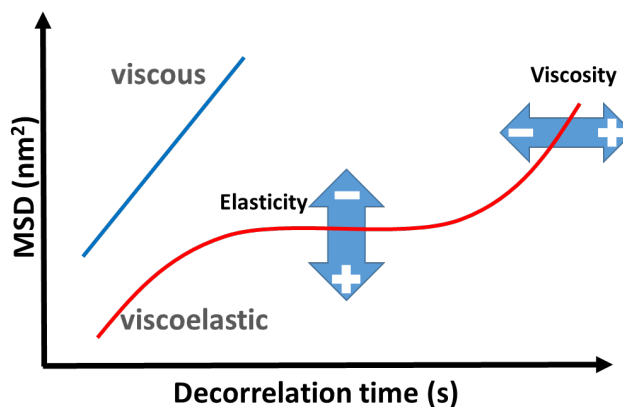


Figure 1. Schematical signatures of MSD curves.

Viscosities were also measured with a rotational rheometer (TA Instruments, AR1500ex, Couette geometry), using a steady state flow step procedure. Reproducible values were obtained only at shear rates equal or higher than 1 s^{-1} . Viscosities were therefore taken at 1 s^{-1} for all concentrations.

Experimental results

A) Xanthan

Xanthan was dispersed at 60°C in concentrations between $2 \cdot 10^{-3}$ and 1% (w/w) until complete dissolution. The mixtures were seeded with 0.1% (w/w) polystyrene particles (1 μm) and cooled down to 25°C. After reaching the equilibrium, samples were measured with Rheolaser Master and the rheometer at 25°C.

One can see in Figure 2 that the viscosities obtained by microrheology (red full squares) are in good correlation with the viscosities measured with conventional rheology (red empty circles).

Remark:

At "high" concentrations (> 0.3%), the viscosities measured with the rheometer are smaller than those measured with the Rheolaser. The reasons for the differences may be related to the differences in method. On the one hand, Rheolaser measures under zero shear conditions, and as a consequence, the gel network formed at this concentration is not disturbed by the measurement. On the other hand, the rheometer is an intrusive method, which can break down or considerably change the network and therefore the viscosity.

B) PEG dispersions

PEG samples (35 kDa) were prepared under slight heating (50°C). After complete dissolution of the polymer, 0.1 % (w/w) polystyrene particles (1 μm) were added. The samples were sonicated for 1 hour in order to release all air bubbles. The dispersions were then stored at 25°C for 3 days before the experiment. Concentrations from 10 to 40 % (w/w) were prepared.

Figure 2 shows the viscosities obtained with Rheolaser (black full squares) and rheometer (black empty circles). There is an overall excellent correlation between the two methods over a wide range of concentrations in that case.

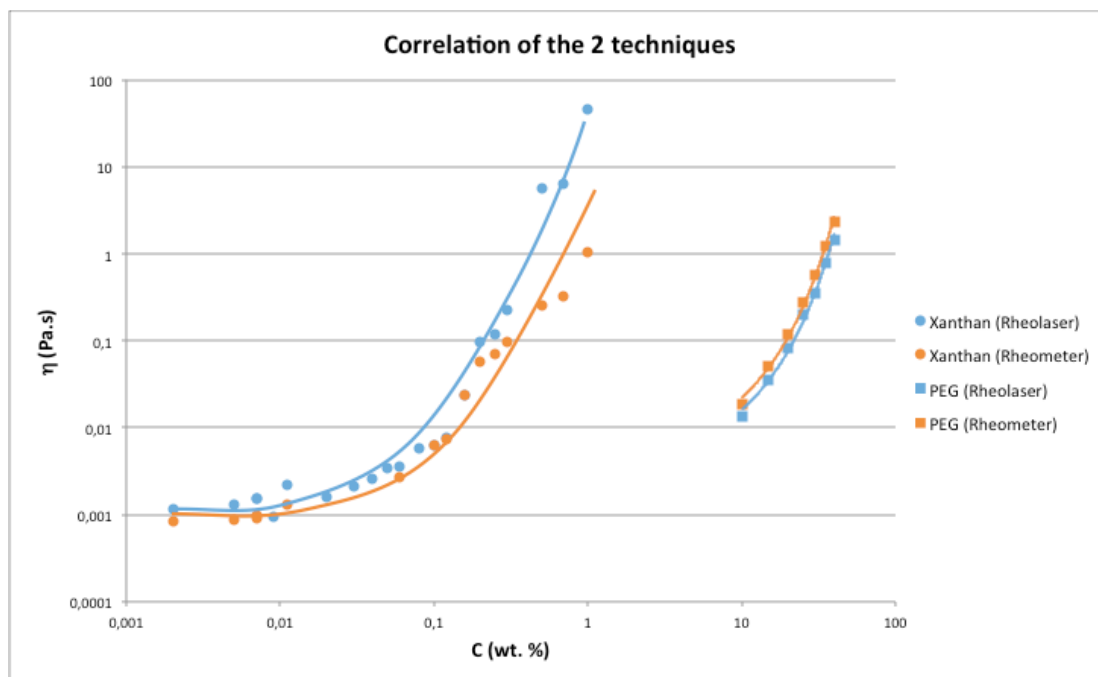


Figure 2. Viscosities (in Pa.s) measured with Rheolaser Master (blue) and rheometer (orange), for xanthan dispersions (circles, $2 \cdot 10^{-3}$ -1 wt.%) and PEG dispersions (squares, 35kDa, 10-40 wt.%)

Benefits

FAST - 6 measurement positions & automatic data treatment

ACCURATE - nano-scale measurement

EASY - Disposable measurement cells, closed environment, 1-click computation