



HAL
open science

On the (Micro)Rheology of Lactoferrin/ β -Lactoglobulin Coacervates

Ghazi Ben Messaoud, Rima Hachfi Soussi, Florence Rousseau, Pascaline Hamon, Marie-Hélène Famelart, Said Bouhallab

► **To cite this version:**

Ghazi Ben Messaoud, Rima Hachfi Soussi, Florence Rousseau, Pascaline Hamon, Marie-Hélène Famelart, et al.. On the (Micro)Rheology of Lactoferrin/ β -Lactoglobulin Coacervates. <https://foodcolloids2024.org/>. 19th Food Colloids Conference, Apr 2024, Thessalonique, Greece. , 2024. hal-04555804

HAL Id: hal-04555804

<https://hal.inrae.fr/hal-04555804>

Submitted on 23 Apr 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



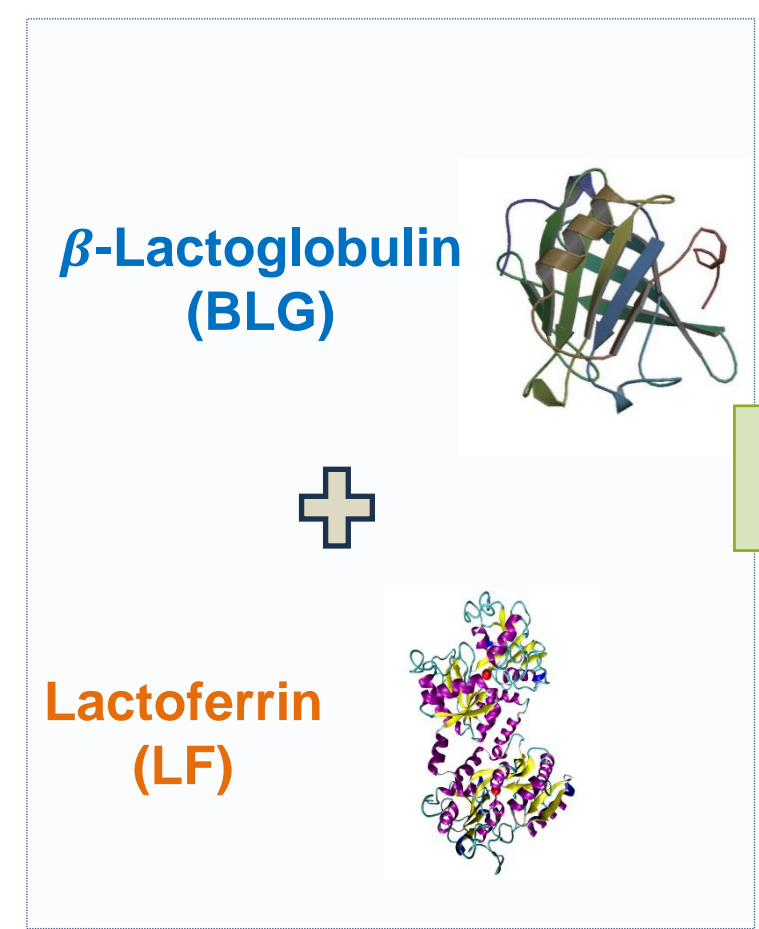
Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

MOTIVATION

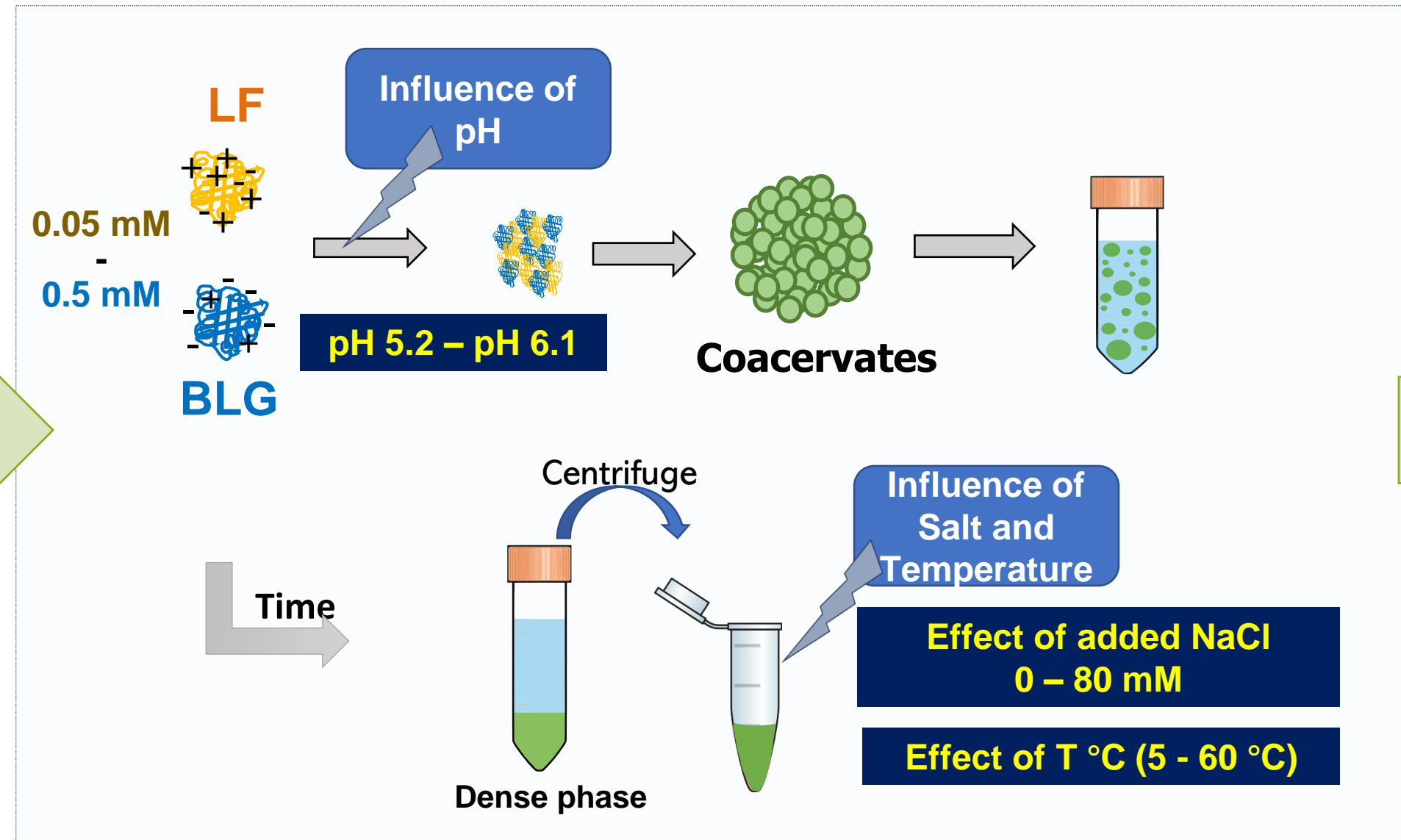
The various applications of heteroprotein complex coacervation have made it of great interest in many fields including food industry. However, the sensitivity of the coacervates to slight changes in the physico-chemical environment deserves to be better understood. In the present study, heteroprotein complex coacervation between positively charged lactoferrin (LF) and negatively charged β-lactoglobulin (BLG) was investigated. The effect of slight change of pH (pH5.2 – pH5.6), ionic strength (up to 80 mM) and temperature (5 – 60 °C) on the rheological properties of LF/BLG coacervates was conducted, as these parameters were proved to be critical for practical applications.

EXPERIMENTAL APPROACH

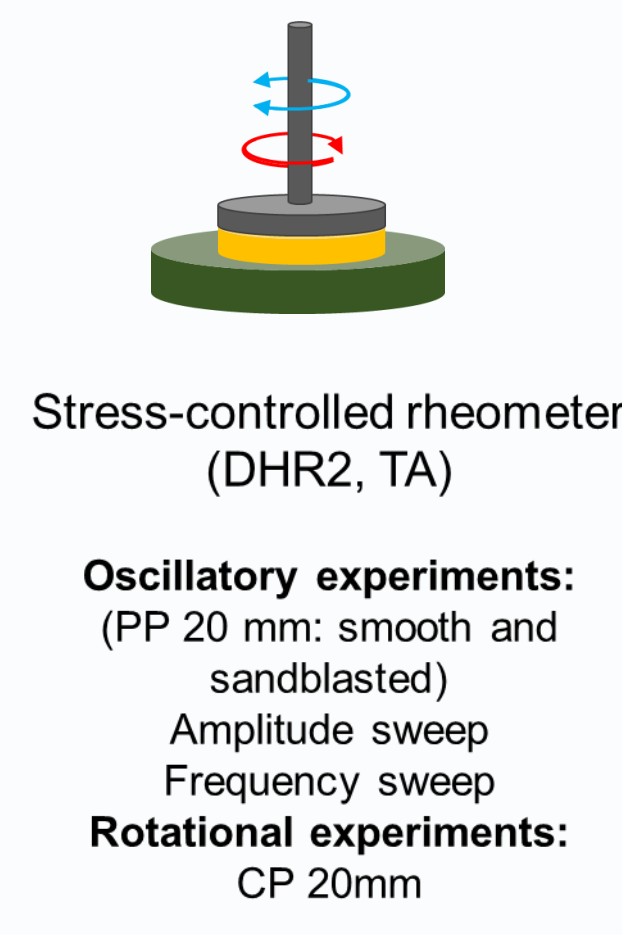
Selected system



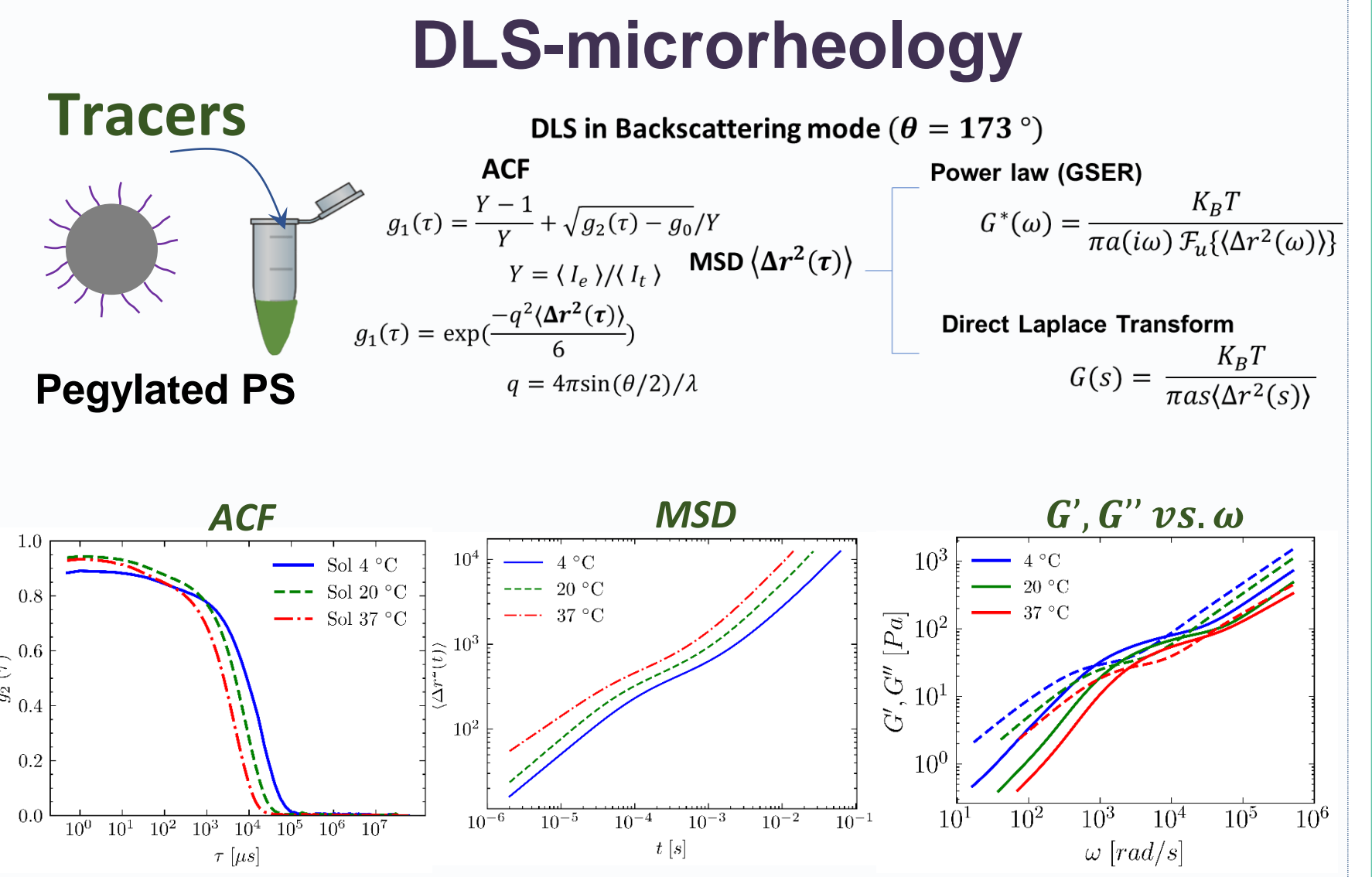
Preparation of BLG/LF coacervates



Rheology

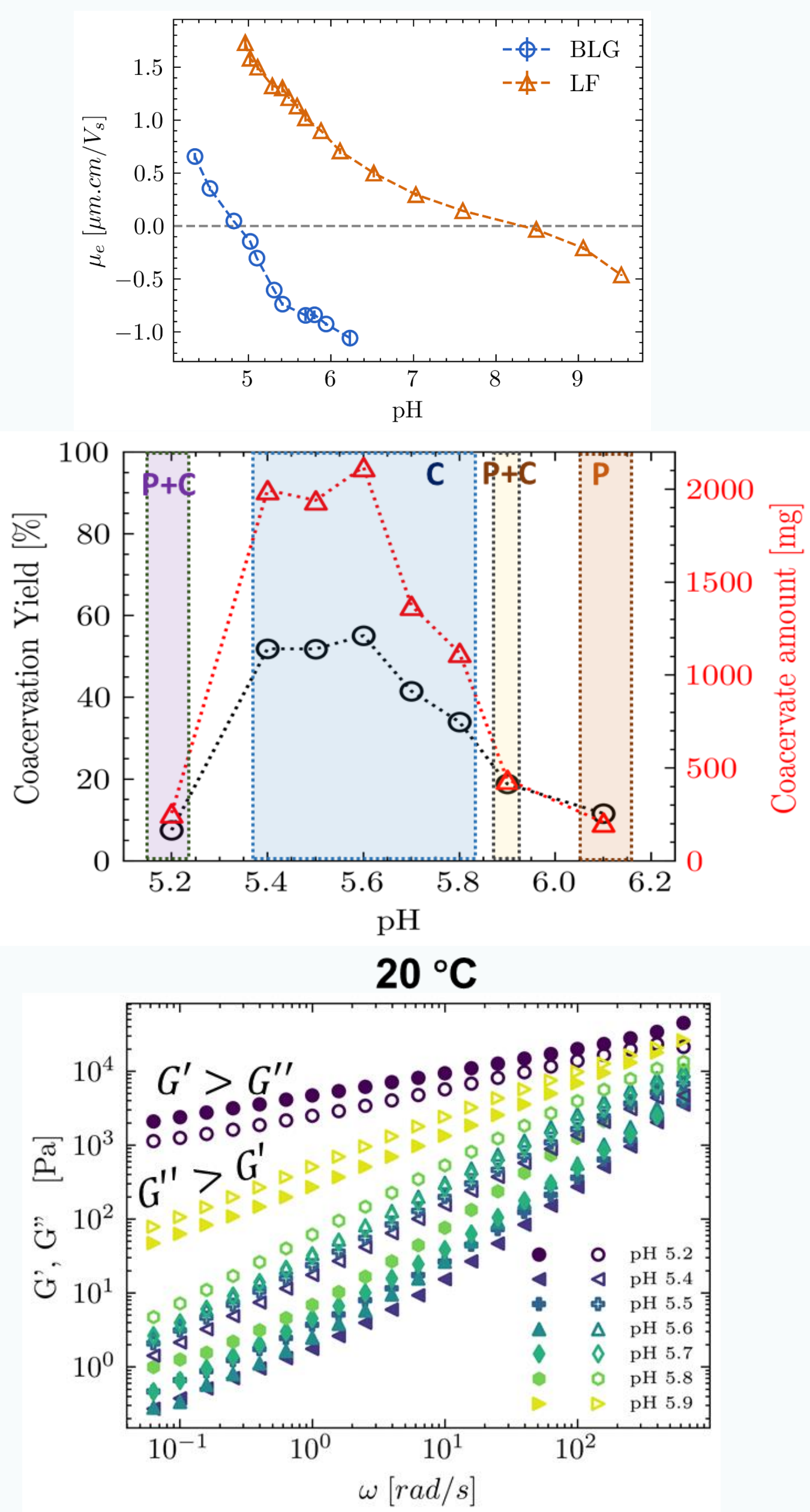


Characterization



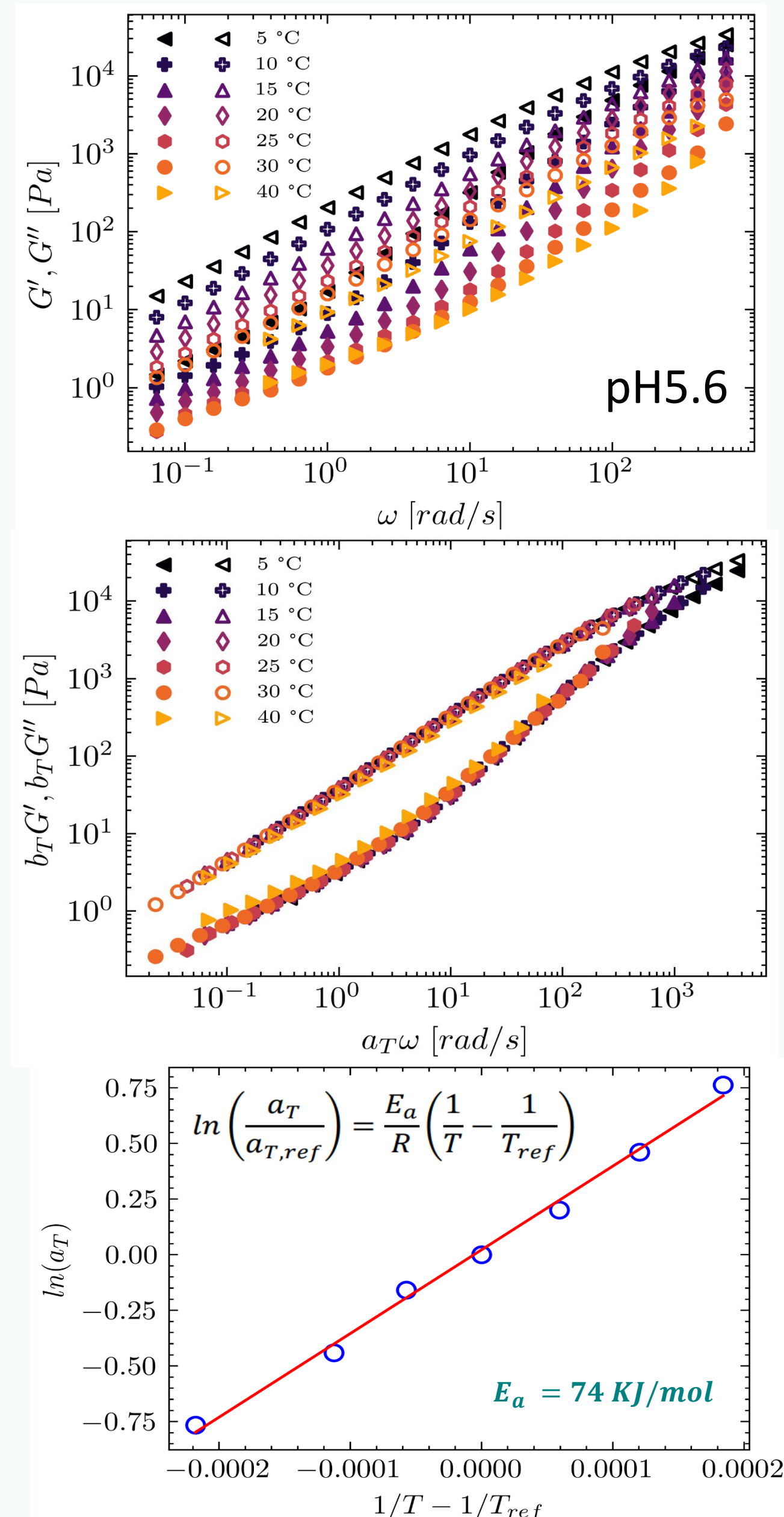
RESULTS & DISCUSSION

Effect of pH



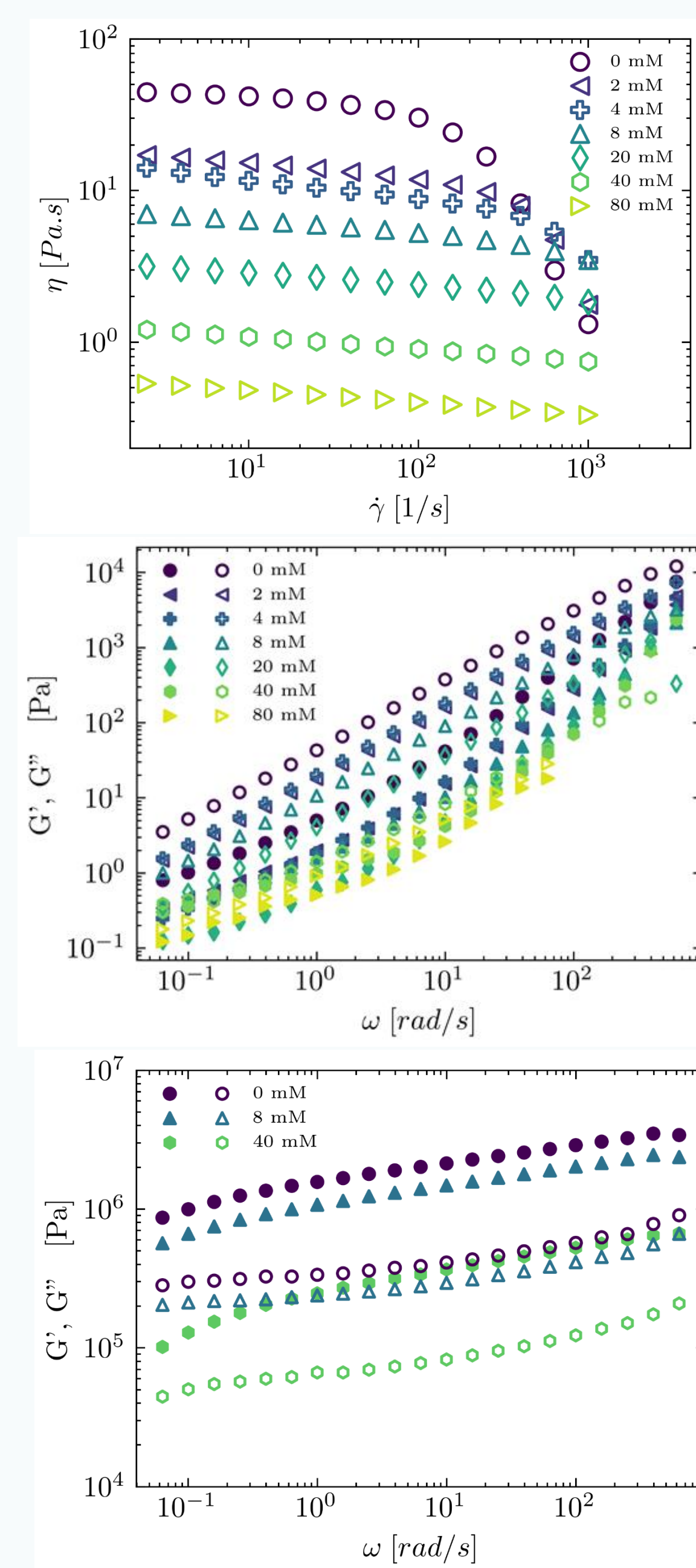
- High sensitivity of the system as a function of pH (0.1 unit).
- pH 5.2: P+C: BLG precipitation close to the I_p ($pH \sim 5$)
- pH5.9 & 6.1: precipitation due to strong electrostatic interaction between BLG and LF

Effect of Temperature



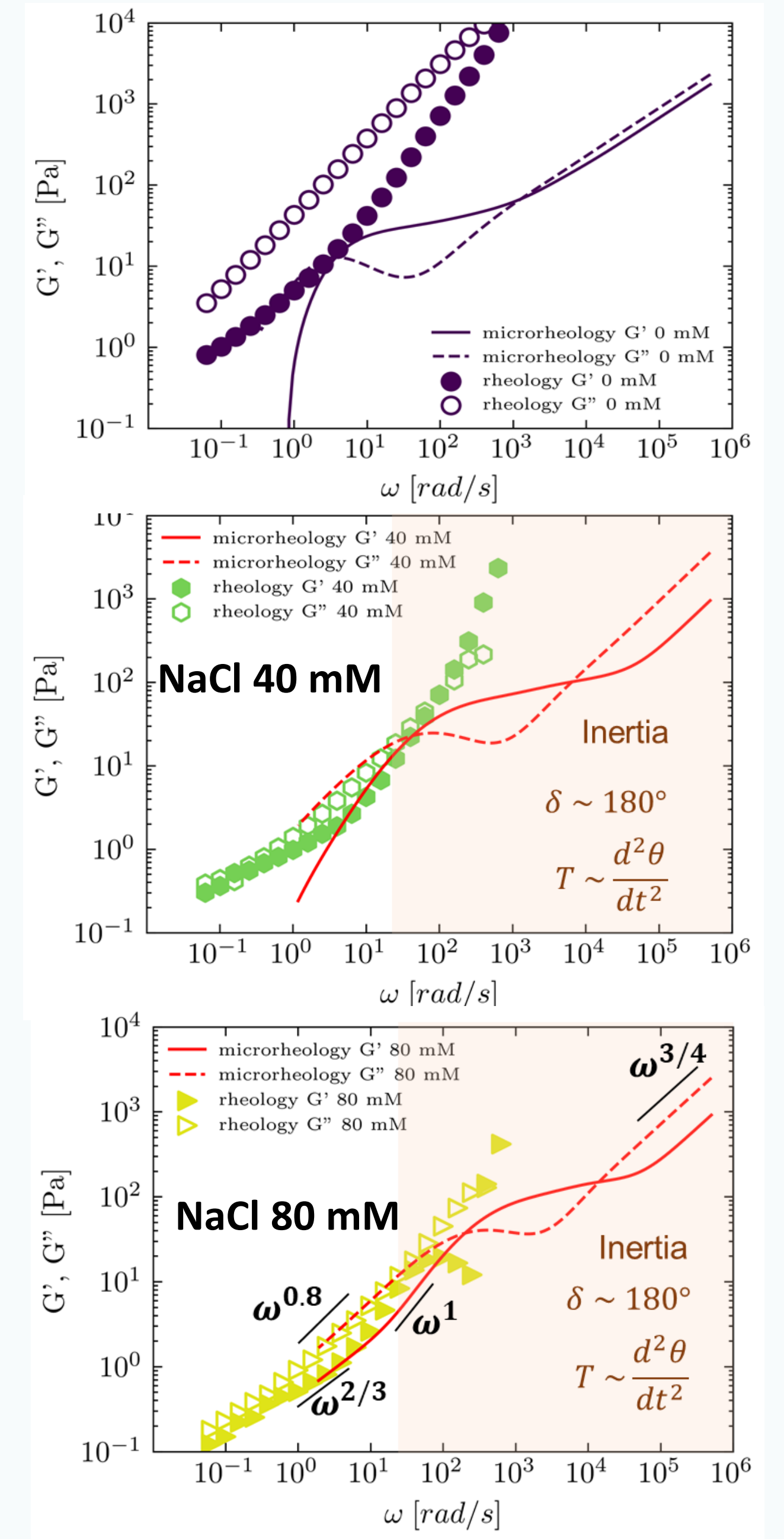
- Heating: accelerate the coacervate's dynamics
- TTS principle applies in the limited range of $T^\circ C$ ($5 \leq T < 50^\circ C$):
- Both proteins show the same T -dependent monomer friction.
- The dynamics of the coacervate is dominated by BLG/LF interactions.

Effect of added NaCl



- Increasing [NaCl]: decrease the viscosity of coacervates and accelerates the coacervates dynamics by a decrease of the number of intrinsic ion pairs and reducing local friction.
- Gelation of the coacervate phase lead to stiff materials ($1 \text{ KPa} < G' < 1 \text{ MPa}$).

Rheology vs. Microrheology



- Up to NaCl 20 mM: Discrepancy between rheology and microrheology: Inaccuracy of microrheology for $G' \sim 10^4 \text{ Pa}$
- Good agreement between rheology and microrheology for NaCl 40 and 80 mM.

CONCLUSION

Fine-tuning pH (0.1 unit): 1) Affect significantly the rheological response from viscoelastic solid to liquid. 2) Optimum coacervation pH range (similar rheological signature): $5.4 \leq pH \leq 5.8$.

Increasing T °C: 1) $5^\circ C \leq T \leq 50^\circ C$: Faster dynamic of coacervates in solution. 2) $50^\circ C \leq T \leq 60^\circ C$: Irreversible gelation of the network.

Addition of NaCl: Decrease the viscoelasticity by reducing the net attractive interactions.

Rheology vs. microrheology: 1) For relatively high G', G'' : Discrepancy at low salt concentration ($[NaCl] < 40 \text{ mM}$).

2) Higher salt concentrations: Good agreement between rheology and microrheology.

Acknowledgements: A part of this research was funded by the Regional council of Brittany and INRAE with an ARED grant n° 3525.