Rheological Characterization of Hydrogels Based on Polymerized Ionic Liquids (PILs)

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Introduction

Polymeric materials such as hydrogels are used in medical applications like implants, for enzyme immobilization and materials for contact lenses.[1] Hydrogels are built up by 3D-crosslinked polymeric structures consisting of a monomer and a crosslinker (N,N'-methylenebisacrylamide) (Fig. 1). This covalently crosslinked networks are obtained, and the mechanical properties were investigated.[2,3]

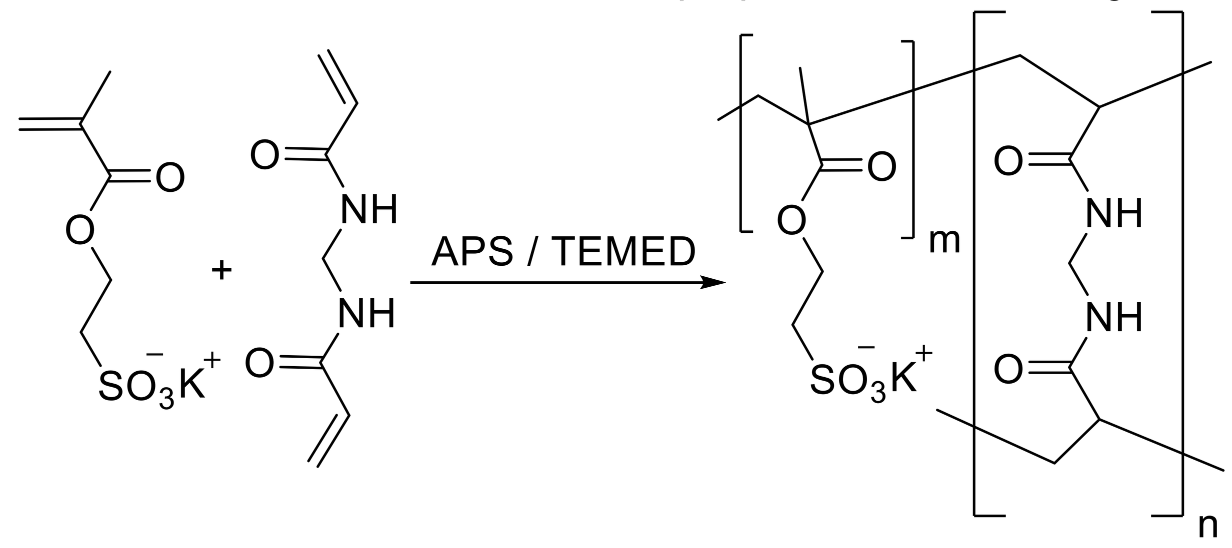


Fig. 1. Hydrogel synthesis [APS = ammonium persulfate; TEMED = N,N,N',N'-Tetramethylethane-1,2-diamine].

Synthesis

The highly functionalized polymeric materials can be easily synthesized from a vast selection of monomers (Fig. 2) with the crosslinker Mbis via radical polymerization. To facilitate a wide range of properties and applications, kationic and anionic monomers were chosen.

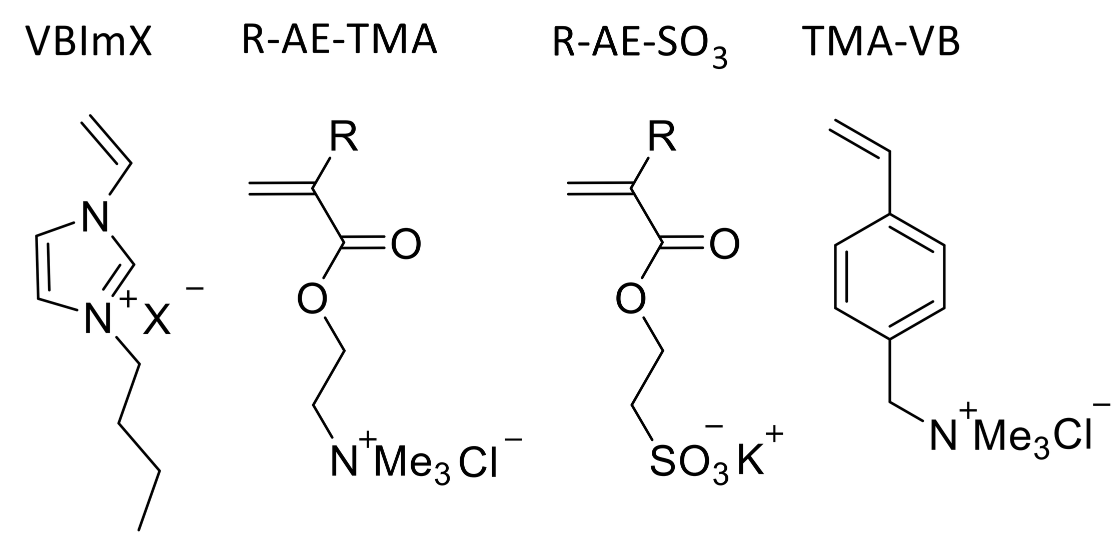


Fig. 2. Overview of the monomers used within this study [X^- = Cl^-, Br^-; R = H, CH_3].

Results and Discussion

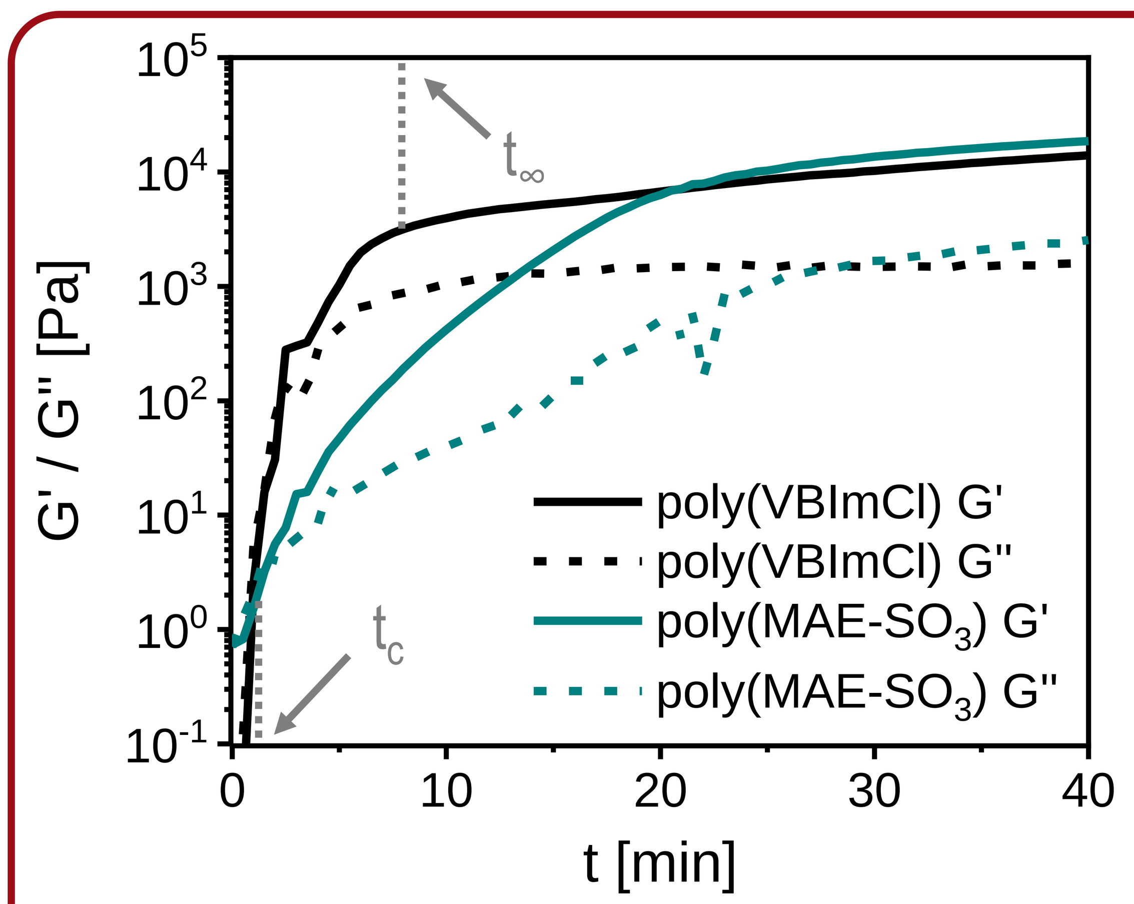


Fig. 3. Polymerization tracking measurements of poly(VBImCl) and poly(MAE-SO3) [21±1°C; ω = 0.1 Hz; γ = 1%].

G'	storage modulus, elastic part, solid behavior
G''	loss modulus, viscous part, liquid behavior

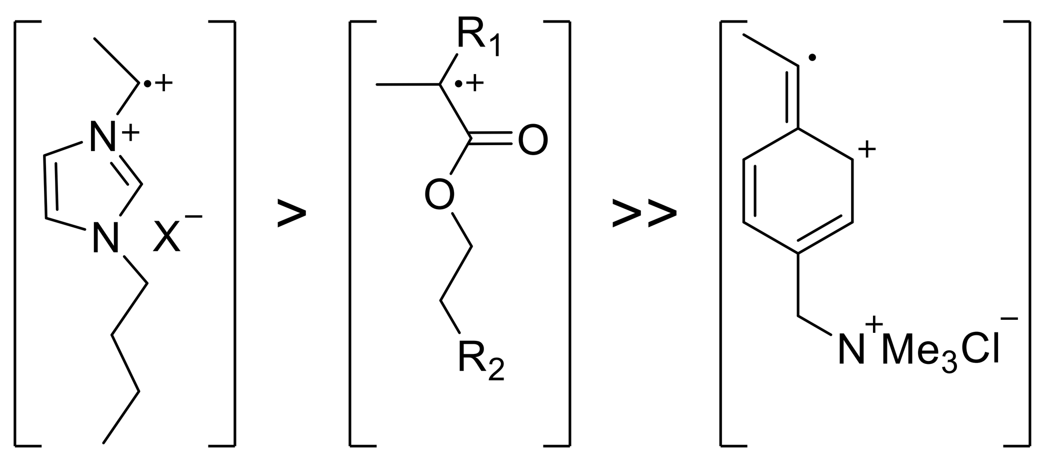


Fig. 4. Mesomeric radical monomer structures and their corresponding polymerization speed [R1 = H, CH_3; R_3 = SO_3K, NMe_3Cl].

	t_c [min]	t_∞ [min]
poly(VBImCl)	2.5	11.0
poly(MAE-SO_3)	1.5	23.5
poly(AE-SO_3)	10.5	10.5
poly(TMA-VB)	38.5	145.0

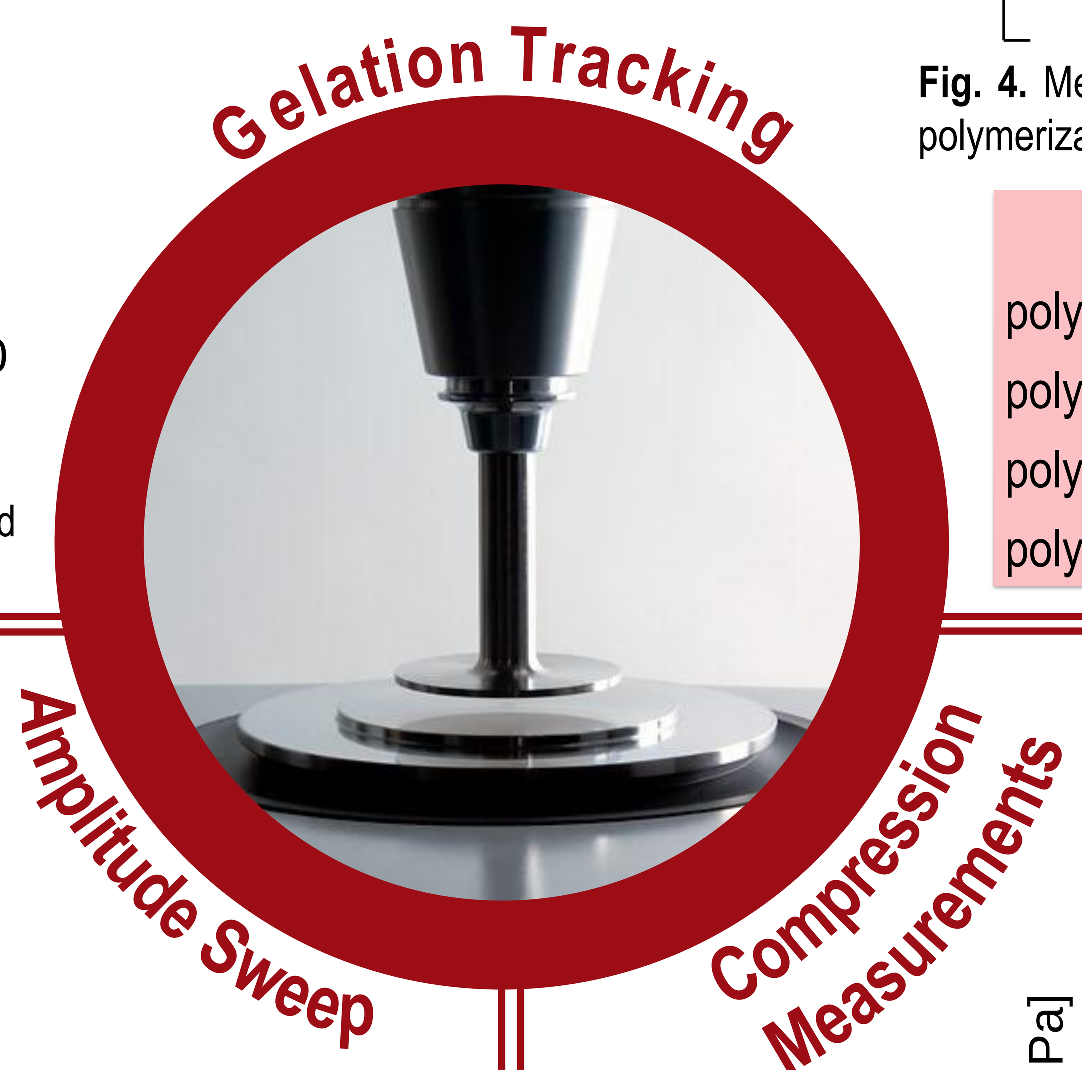
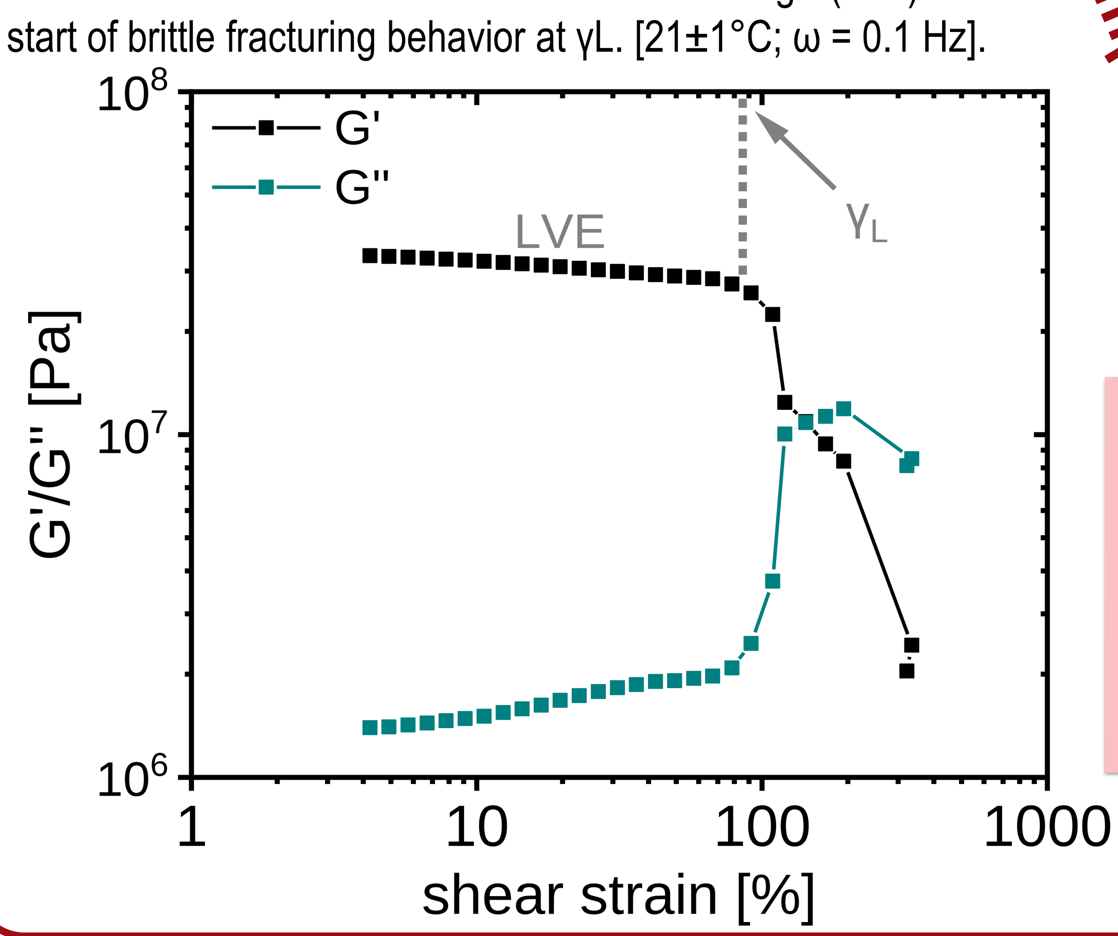
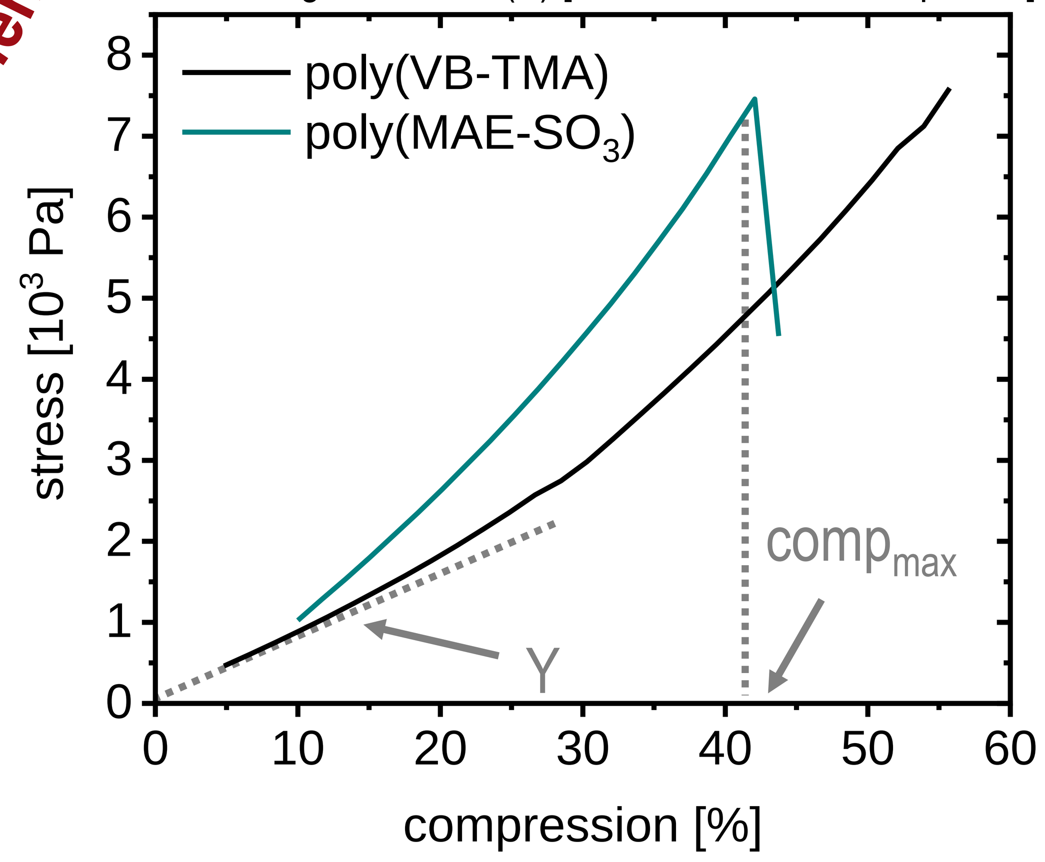


Fig. 5. Strain-sweep measurements on poly(MAE TMA), giving an information about the linear viscoelastic range (LVE) and the start of brittle fracturing behavior at γL. [21±1°C; ω = 0.1 Hz].



	γL [%]	$comp_{max}$ [%]	Y [Pa]
poly(VBImCl)	91	7.8	1084.0
poly(MAE-SO_3)	92	41.2	164.1
poly(MAE-TMA)	171	39.2	118.8
poly(TMA-VB)	181	53.9	90.8

Fig. 6. Compression curves of poly(MAE TMA) and poly(VB-TMA), giving information about the maximum of compression and the Young's modulus (Y) [21±1°C; ω = 0.1 Hz; γ = 1%].



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Acknowledgements:
Financial support by Bundesministerium für Bildung und Forschung, Germany (project number: 032091 0 B) is gratefully acknowledged.

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