

SUPPLEMENTAL MATERIALS

ASCE *Journal of Materials in Civil Engineering*

Thermal Aging of Bitumen and Biorejuvenator Blends: Triglyceride versus Free Fatty Acids

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DOI: 10.1061/(ASCE)MT.1943-5533.0004258

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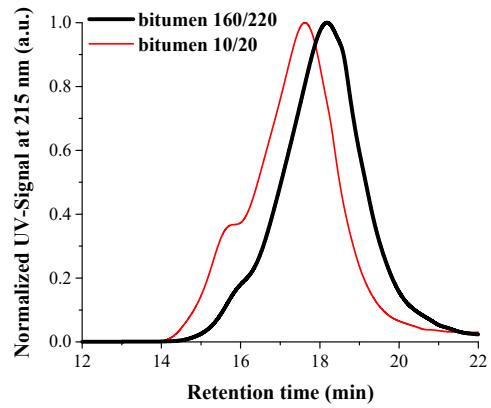


Figure S1 Gel permeation chromatography (GPC) curves at the wavelength of 215 nm for bitumen 160/220 and bitumen 10/20.

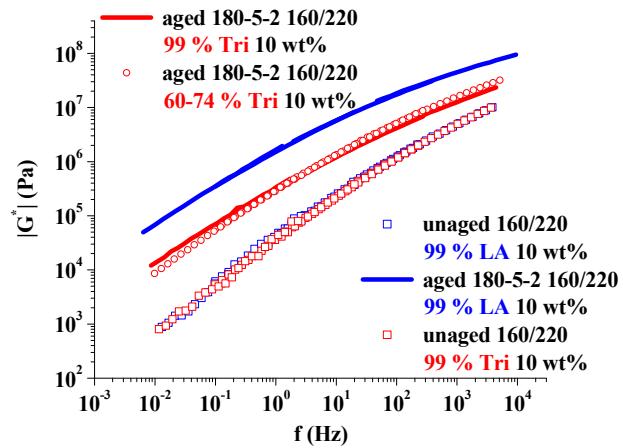


Figure S2 c) $|G^*|$ as a function of frequency for the aged mixtures at 180 °C for 5 h of bitumen 160/220 and rejuvenators with lower and higher purity (99 %). OA: oleic acid, LA: linoleic acid and Tri: triolein.

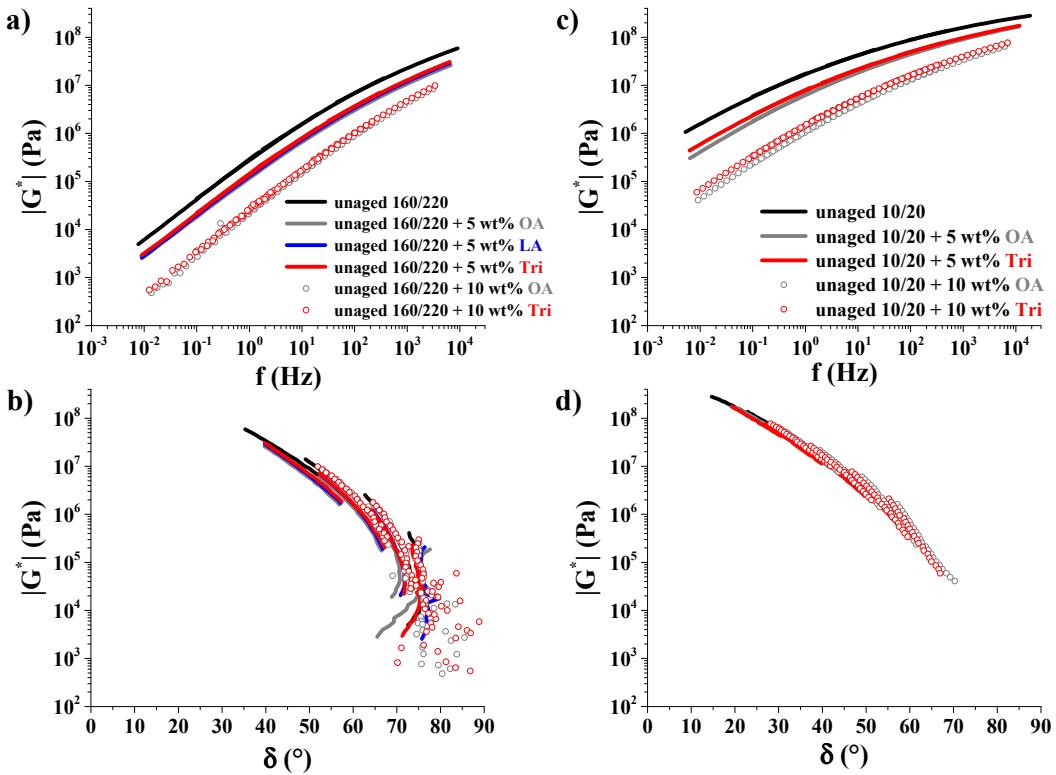


Figure S3 $|G^*|$ as a function of frequency (a, c) and as a function of the phase angle δ (b, d) for the mixtures of unaged bitumen 160/220 (a, b) and unaged bitumen 10/20 (c, d) mixed with unaged rejuvenators OA: oleic acid, LA: linoleic acid and Tri: triolein.

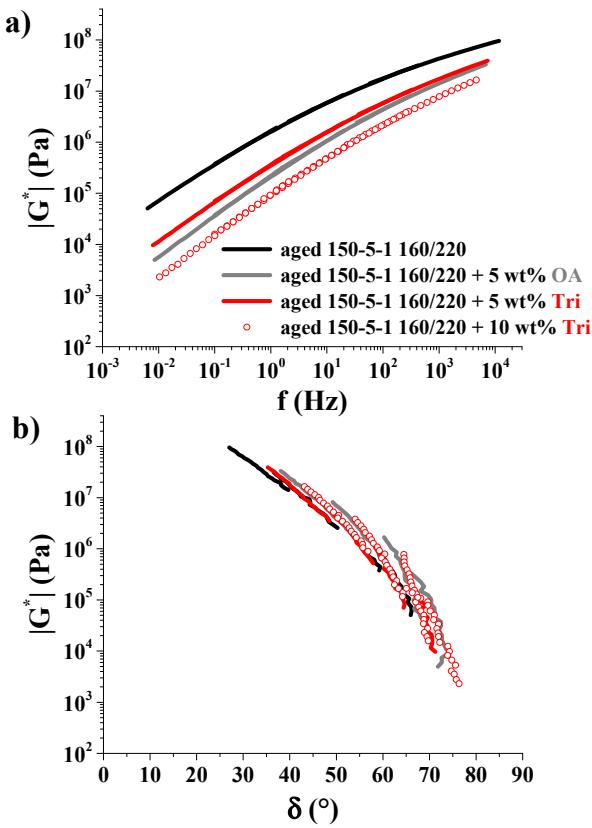


Figure S4 a) $|G^*|$ as a function of frequency and b) as a function of the phase angle δ for the mixtures of aged bitumen 160/220 at 150 °C for 5 h and unaged rejuvenators. OA: oleic acid and Tri: triolein.

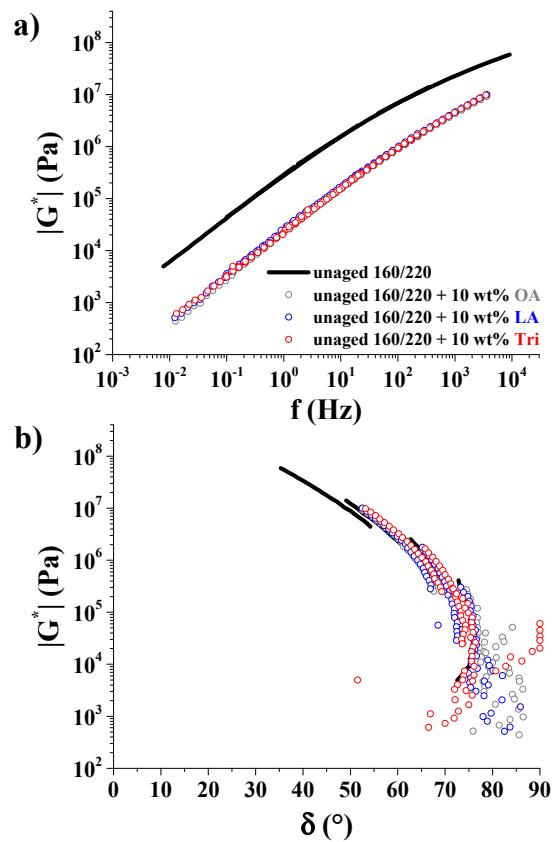


Figure S5 a) $|G^*|$ as a function of frequency and b) as a function of phase angle δ for the mixtures of unaged bitumen 160/220 and aged rejuvenators at 180 °C for 5 h. OA: oleic acid, LA: linoleic acid and Tri: triolein.

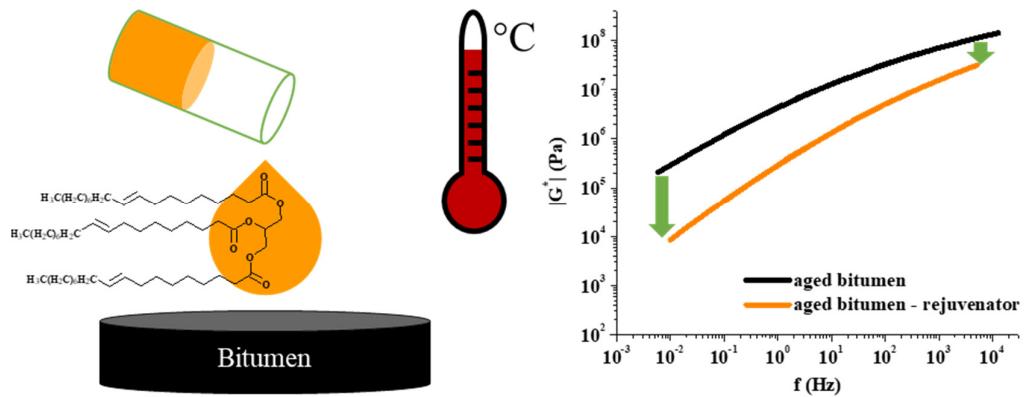


Figure S6 Graphic Abstract

Table S1 Band locations in the spectra of oleic (OA), linoleic acid (LA) and triolein (Tri) for the different functional groups and assignments of the various modes of vibration.

Wavenumber (cm^{-1})	Functional group and mode of vibration
3009	=CH <i>cis</i> stretching LA
3006	=CH <i>cis</i> stretching OA, Tri
2954	CH (CH_3) asymmetric stretching
2921	CH (CH_2) asymmetric stretching
2853	CH (CH_2) symmetric stretching
2672	OH (from dimeric COOH) stretching OA, LA
1745	C=O ester Fermi resonance Tri
1708	C=O stretching OA, LA
1655	C=C stretching OA, LA, Tri
1461	CH (CH_2 , CH_3) asymmetric bending OA, LA, Tri
1378	CH (CH_3) symmetric bending OA, LA, Tri
1285	CO stretching OA, LA
1239	CO stretching and CH_2 bending Tri
1165	CO stretching and CH_2 bending Tri
1117	CO stretching OA, LA, Tri
1095	CO stretching OA, LA, Tri
967	=CH trans out-of-plane deformation Tri
935	OH stretching OA, LA
722	CH_2 rocking vibration (long alkyl chains) OA, LA, Tri

Table S2 Approximate band locations in the ATR-FTIR spectra of bitumen for the different functional groups and assignments of the various modes of vibration.

Wavenumber (cm ⁻¹)	Functional group and mode of vibration
2952	CH (CH ₃) asymmetric stretching
2918	CH (CH ₂ , CH ₃) asymmetric stretching
2850	CH (CH ₂ , CH ₃) symmetric stretching
1698	C=O stretching
1594	C=C stretching
1457	CH (CH ₂ , CH ₃) asymmetric bending
1375	CH (CH ₃) symmetric bending
1306	SO (SO ₂) stretching
1030	S=O stretching
910-730	CH (aromatic) stretching
721	CH ₂ rocking vibration (long alkyl chains)