nanomaterials

# Supplementary Materials

# Enhancement of Gas Barrier Properties and Durability of Poly(butylene Succinate-Co-butylene Adipate)-Based Nanocomposites for Food Packaging Applications

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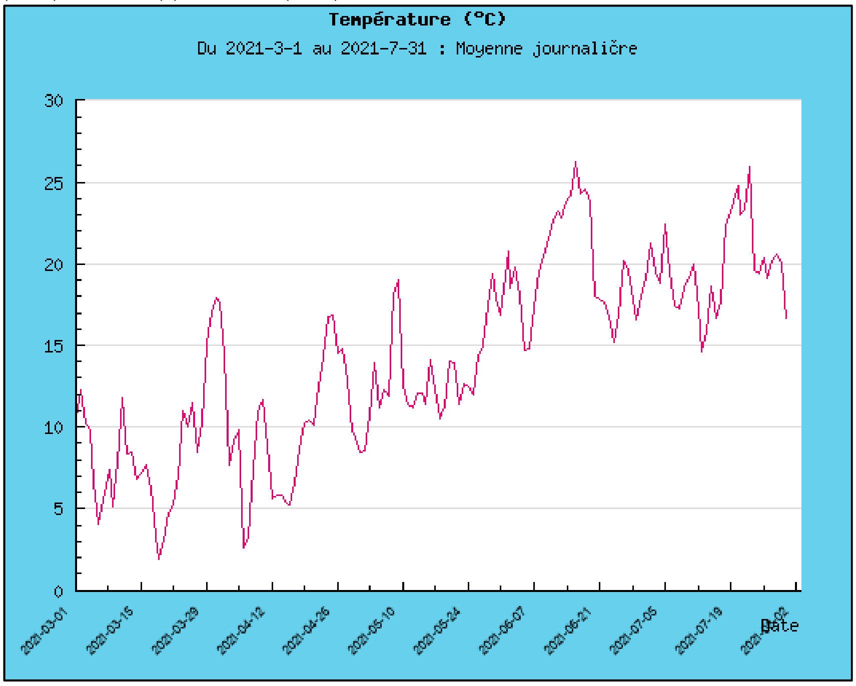


**Figure S1.** Average daily temperature measured at Cézeaux station (45°45'37 N − 3°06'43 E 394 m asl.) during the period of sampling from March 2021 to July 2021. The data was obtained from Observatoire de Physique du Globe de Clermont-Ferrand (http://wwwobs.univ-bpclermont.fr/SO/mesures/pdd.php) (accessed on 01/12/2021).

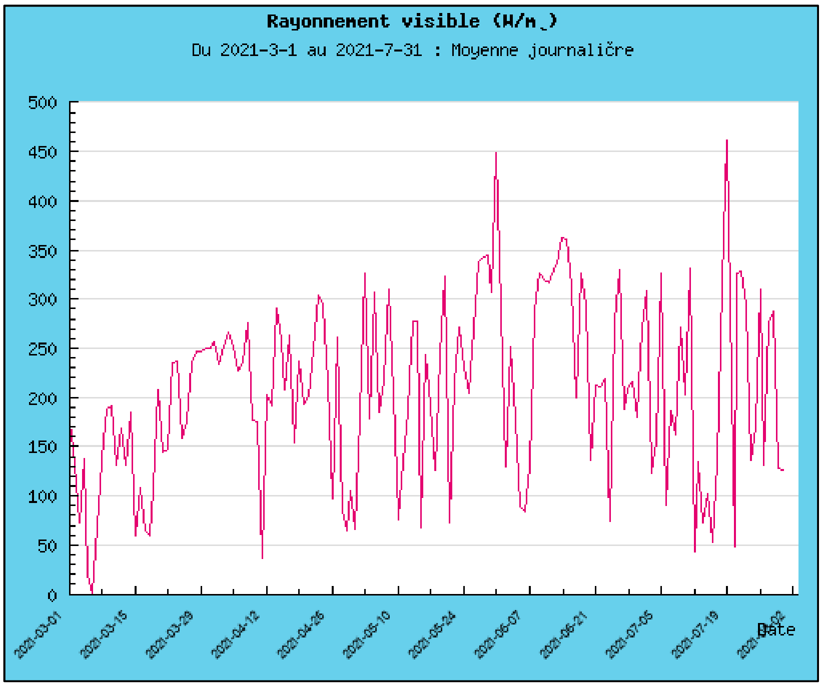


**Figure S2.** Average UV radiation measured at Cézeaux station (45°45'37 N − 3°06'43 E, 394 m asl.) during the period of sampling from March 2021 to July 2021. The data was obtained from Observatoire de Physique du Globe de Clermont-Ferrand (http://wwwobs.univ-bpclermont.fr/SO/mesures/pdd.php) (accessed on 01/12/2021).

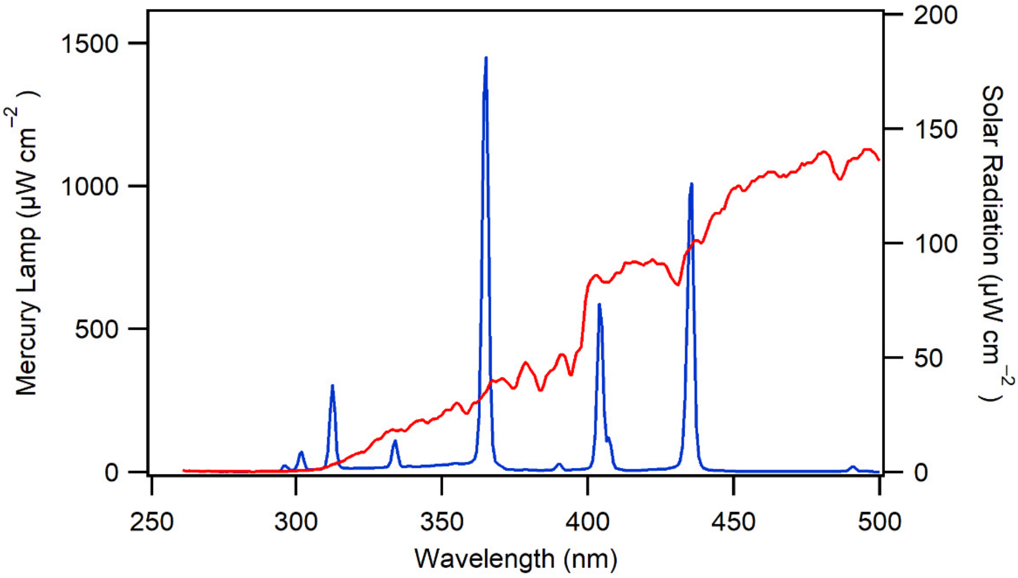


**Figure S3.** Emission spectrum of a Mercury lamp used in the SEPAP machine (blue line) and Solar radiation arriving at earth (red line).

## Size analyses from SEM images

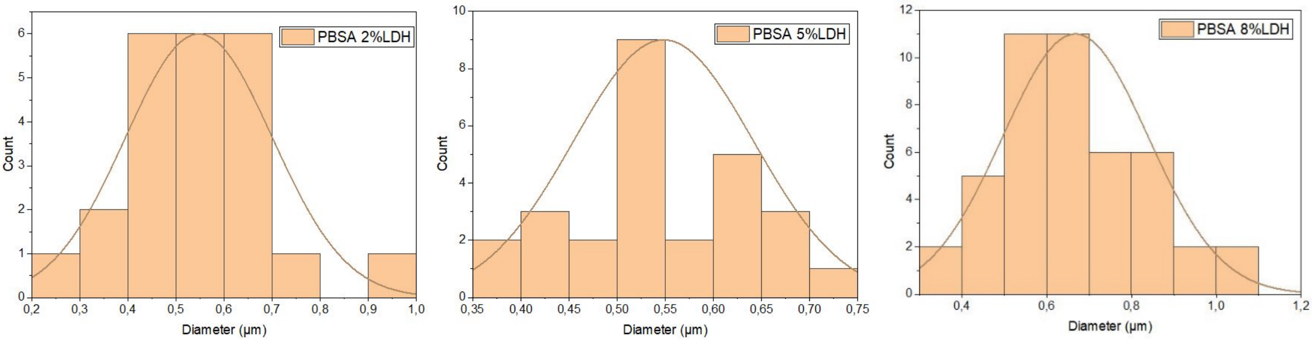


**Figure S4.** Size distribution (diameter) of detected LDH particulates in SEM images, treated with ImageJ software. The majority (>90%) of the detected particulates are equal or smaller than average SORBACID® 911 particle size (d50) of ≤ 1 µm.

## Thermal analyses

**Table S1.** TGA results of PBSA and PBSA composites.

| Sample | Onset of decomposition, °C | Temperature at 50% weight loss, °C | Peak of 1st derivative, °C | Residue at 600 °C, % |
|---|---|---|---|---|
| PBSA | 372.4 | 398.5 | 401.8 | 1.34 |
| PBSA + 2% LDH | 338.5 | 367.8 | 376.8 | 5.3 |
| PBSA + 5% LDH | 317.3 | 351.8 | 360.2 | 6.1 |
| PBSA + 8% LDH | 331.0 | 356.2 | 355.2 | 5.4 |

## Infrared spectroscopy pf PBSA and PBSA-LDH nanocomposite

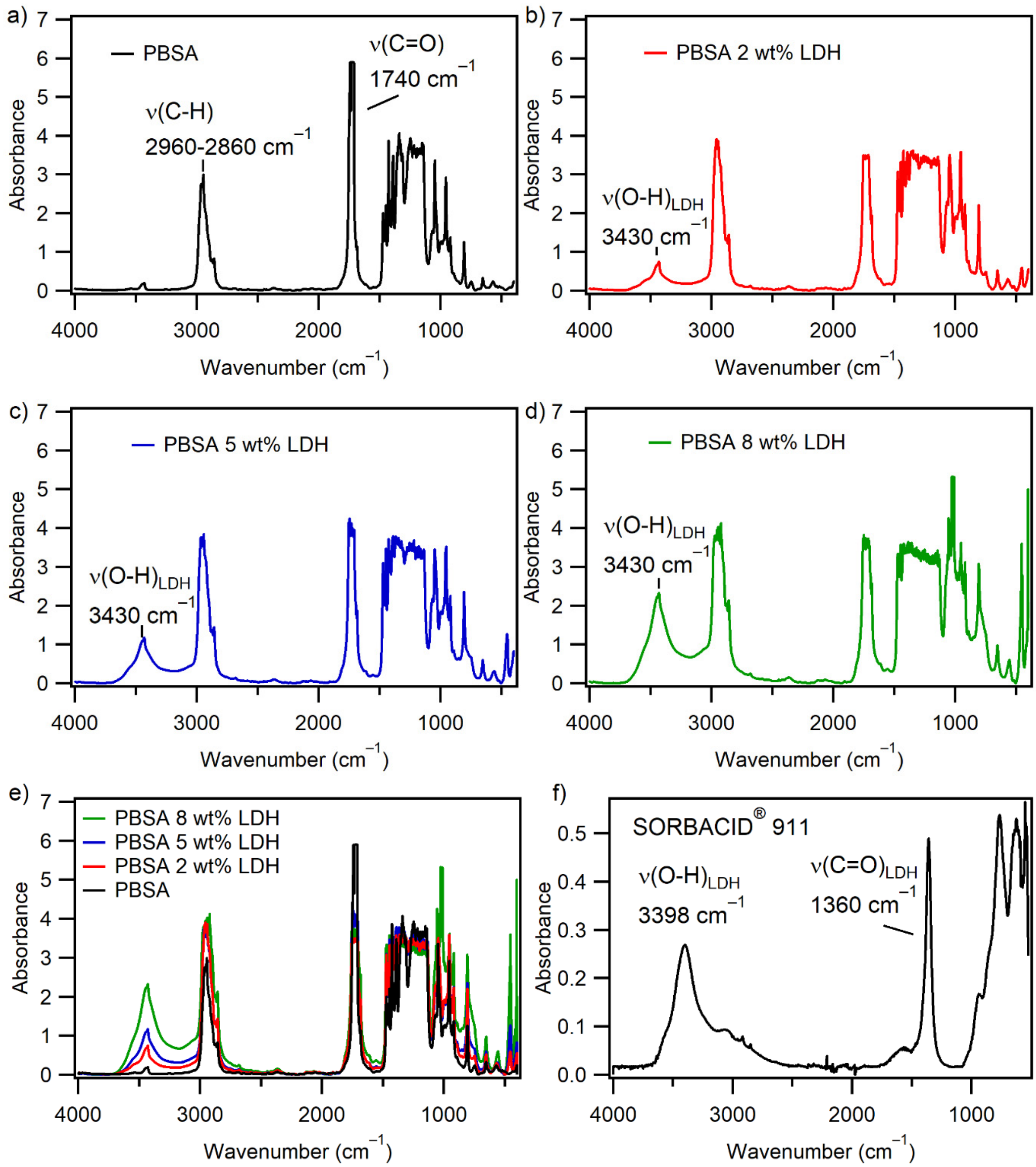


**Figure S5.** FT-IR spectra of (**a**) PBSA (**b**) PBSA 2 wt% LDH, (**c**) PBSA 5 wt% LDH and (**d**) PBSA 8 wt% LDH. The spectra of neat PBSA and PBSA-LDH nanocomposites are compared in (**e**) and the IR spectrum of SORBACID® 911 is shown in (**f**).

## UV-Vis spectra of PBSA-LDH films

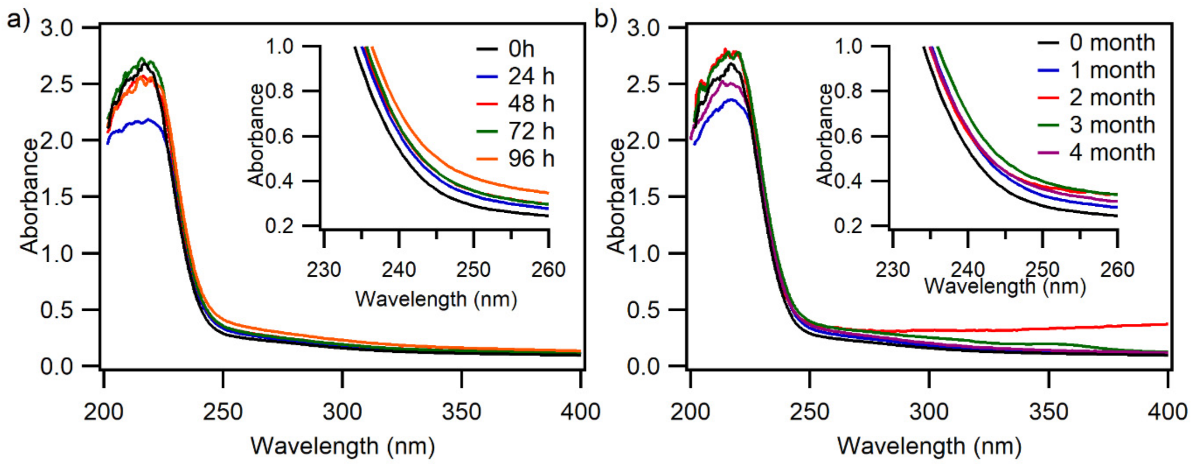


**Figure S6.** UV-Vis spectra of PBSA before exposure to UV-radiation (black line) and (**a**) after 24 hrs (blue line), 48 h (red line), 72 h (green line), 96 h (orange line) exposure to UV-radiation, and after (**b**) 1 month (blue line), 2 months (red line), 3 months (green line) and 4 months (orange line) of being exposed to natural weathering.

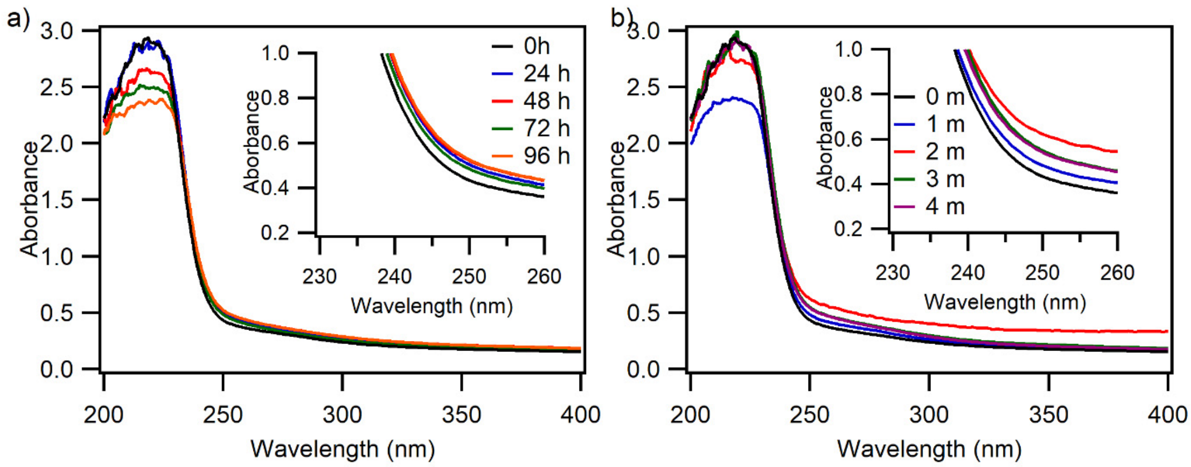


**Figure S7.** UV-Vis spectra of PBSA + 2% LDH before exposure to UV-radiation (black line) and (**a**) after 24 h (blue line), 48 h (red line), 72 h (green line), 96 h (orange lineexposure to UV-radiation, and after (**b**) 1 month (blue line), 2 months (red line), 3 months (green line) and 4 months (orange line) of being exposed to natural weathering.

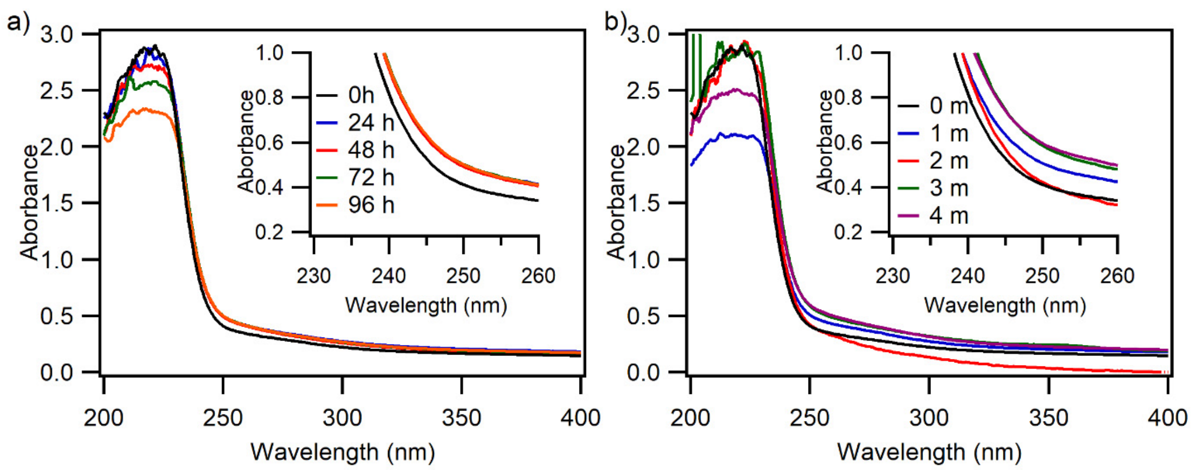

**Figure S8.** UV-Vis spectra of PBSA + 5% LDH before exposure to UV-radiation (black line) and (**a**) after 24 h (blue line), 48 h (red line), 72 h (green line), 96 h (orange line) exposure to UV-radiation in the SEPAP, and after (**b**) 1 month (blue line), 2 months (red line), 3 months (green line) and 4 months (orange line) of being exposed to natural weathering.

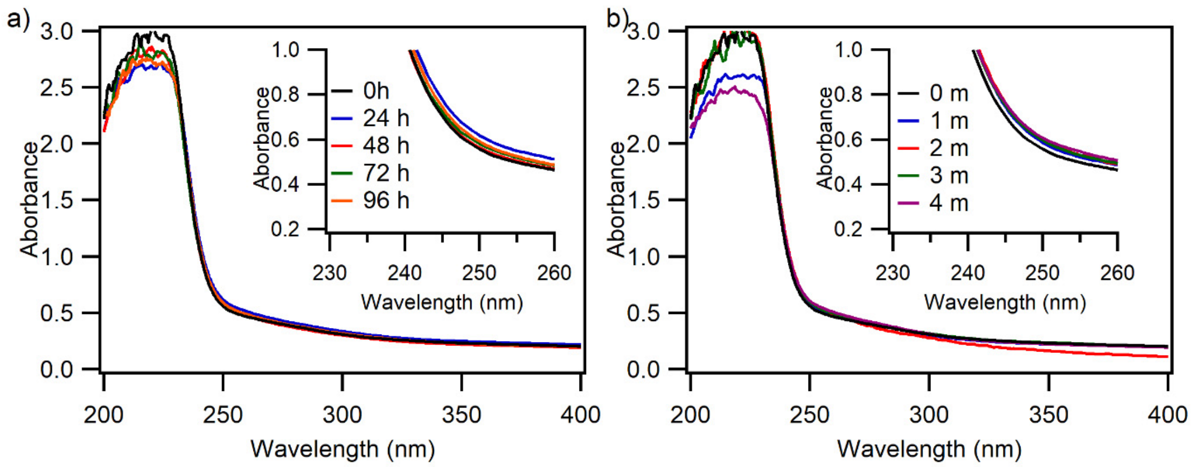


**Figure S9.** UV-Vis spectra of PBSA + 8% LDH before exposure to UV-radiation (black line) and (**a**) after 24 h (blue line), 48 h (red line), 72 h (green line), 96 h (orange line) exposure to UV-radiation in the SEPAP, and after (**b**) 1 month (blue line), 2 months (red line), 3 months (green line) and 4 months (orange line) of being exposed to natural weathering.

**Melt Rheology.**

Melt rheology provides a convenient tool to study the competition of chain scissions and recombination reactions occurring through aging of polymers. It is well-known that the zero shear viscosity, $\eta_0$. depends on the molecular weight ($M_W$) and obeys to a power law as described in equation 1[1, 2].

$$\eta_0 \propto M_W^{\propto}, \quad (1)$$

The change in molecular weight of a polymeric material as result of degradation provides valuable information of degradation pathways at a molecular level. By measuring the $\eta_0$ over the time of aging of a polymer. The changes in $\eta_0$ can indicate whether there is a change in molecular weight of the polymer. A change in the molecular weight as a polymer is aged suggests that a transformation at the molecular level has occurred. leading either to a higher or lower molecular weight. A lower $\eta_0$ of a polymer than its initial $\eta_0$ corresponds to lower molecular weight. the polymer has been subjected to a chain scission mechanism. Vice versa a higher $\eta_0$ correlates to higher molecular weight of the polymer and the polymer has been subjected to a transformation described as a chain recombination mechanism. The $\eta_0$ is obtained through the extrapolation of the arc of the circle of a cole-cole model which predicts the variation of the viscosity components ($\eta''$ versus $\eta'$) to be an arc of circle in the complex plane. This is explained more in detail elsewhere by Commereuc and co-workers[1, 2].

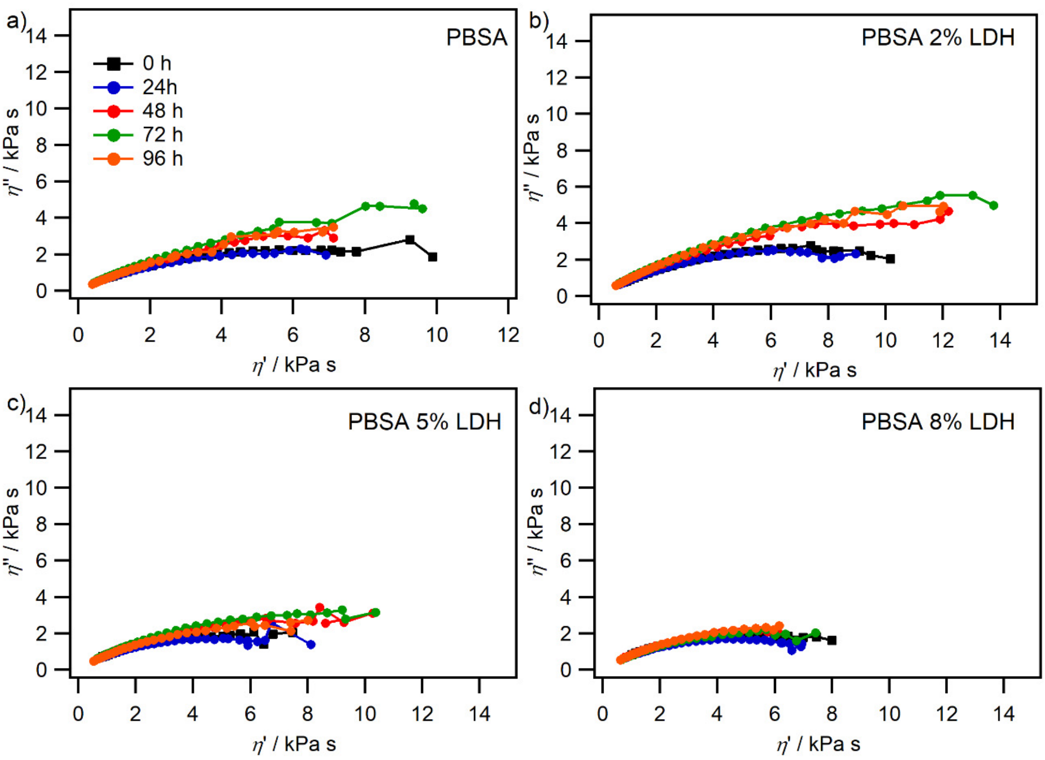


**Figure S10.** Cole-cole plots of unaged and aged (**a**) PBSA (**b**) PBSA 2 wt% LDH, (**c**) PBSA 5 wt% LDH and (**d**) PBSA 8 wt% LDH in the accelerated photoaging chamber.

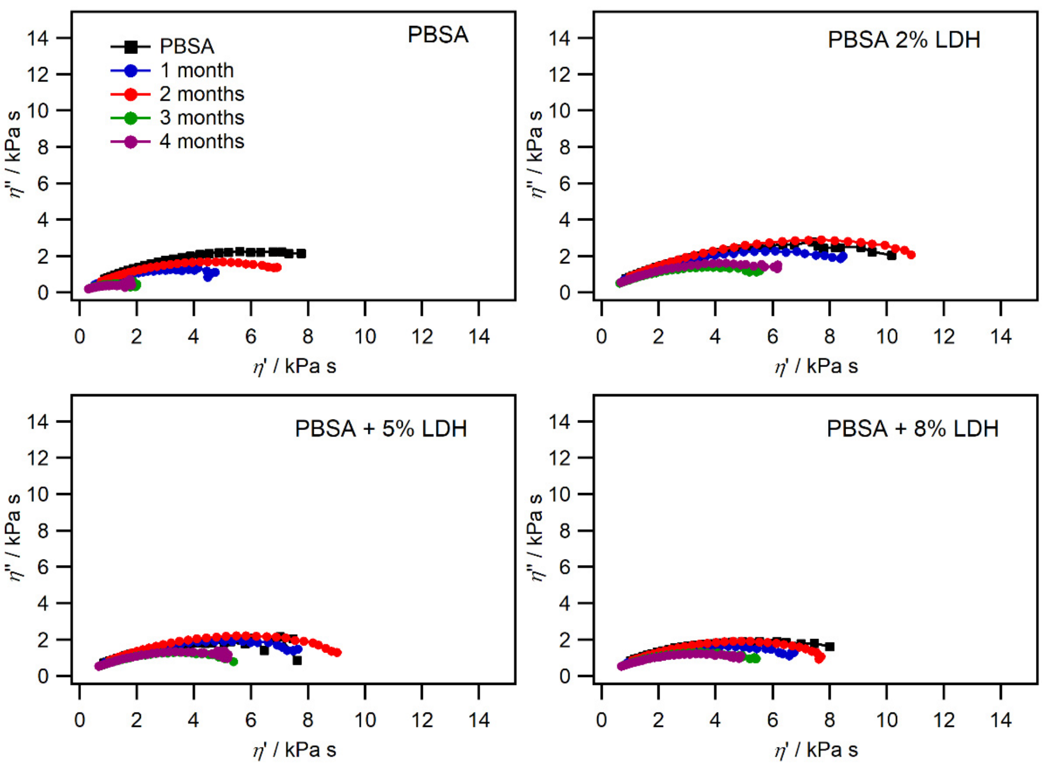


**Figure S11.** Cole-cole plots of naturally weathered (**a**) PBSA (**b**) PBSA 2 wt% LDH, (**c**) PBSA 5 wt% LDH and (**d**) PBSA 8 wt% LDH.

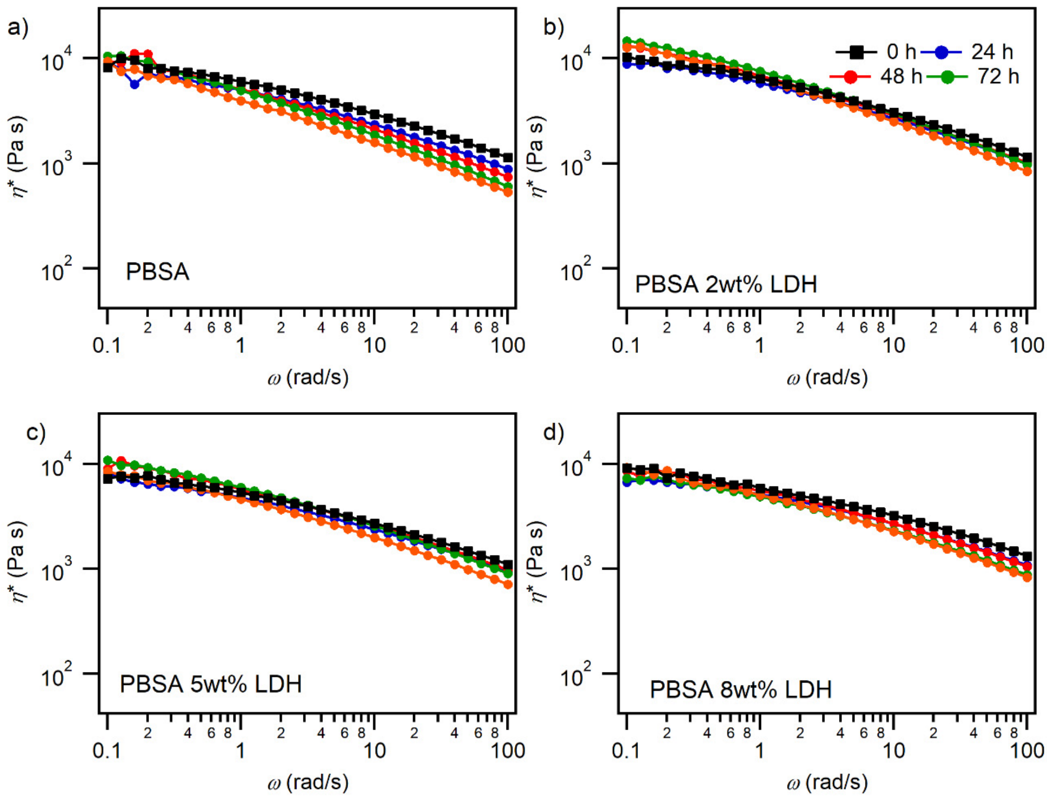


**Figure S12.** Dynamic viscosity relationship with frequency of unaged and aged (**a**) PBSA (**b**) PBSA 2 wt% LDH, (**c**) PBSA 5 wt% LDH and (**d**) PBSA 8 wt% LDH in SEPAP.

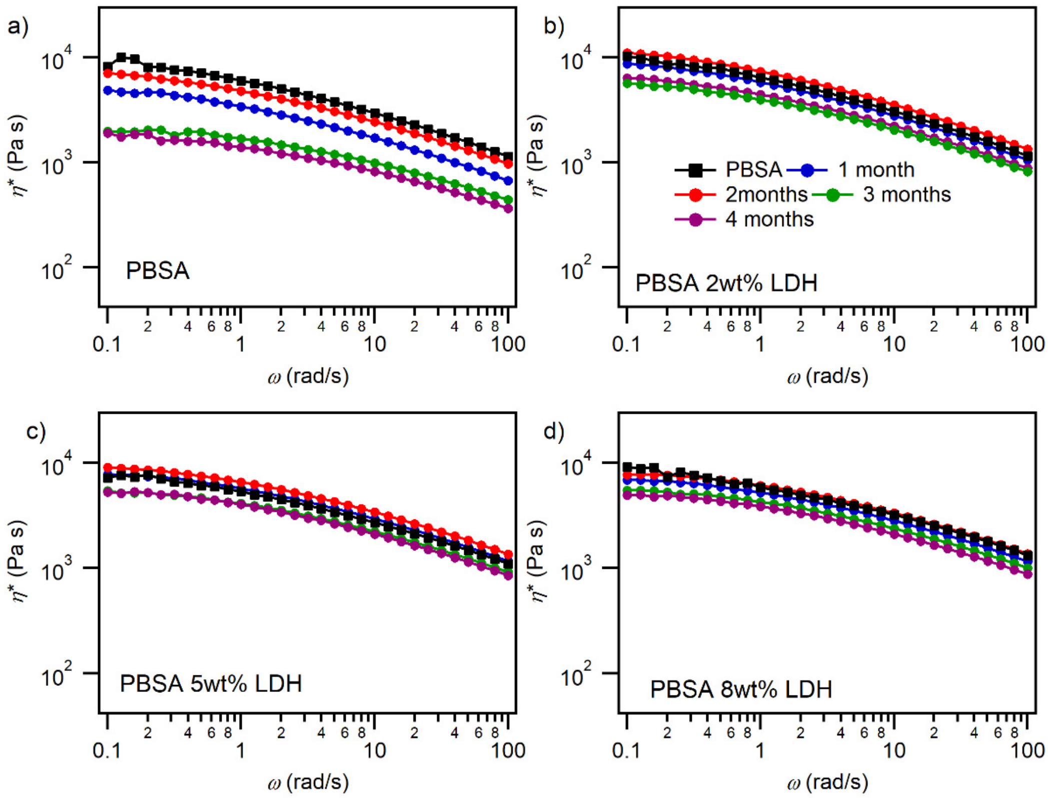


**Figure S13.** Dynamic viscosity relationship with frequency of naturally weathered (**a**) PBSA (**b**) PBSA 2 wt% LDH, (**c**) PBSA 5 wt% LDH and (**d**) PBSA 8 wt% LDH.