Supporting Information

Lignin Nanoparticles: Promising Sustainable Building Block of Photoluminescent and Haze Film for Improving Efficiency of Solar Cells

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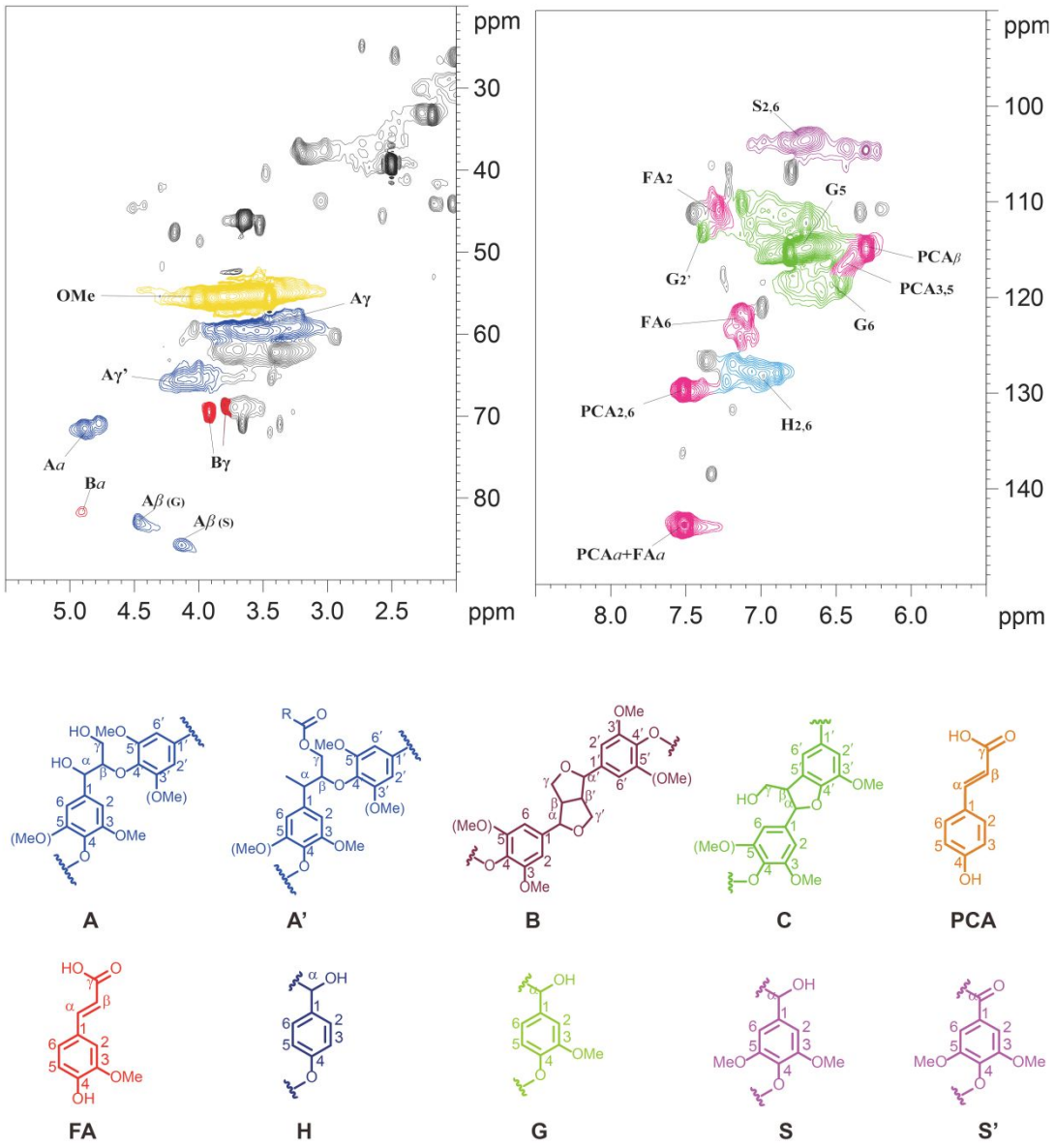

Figure S1. 2D HSQC NMR spectra of lignin.

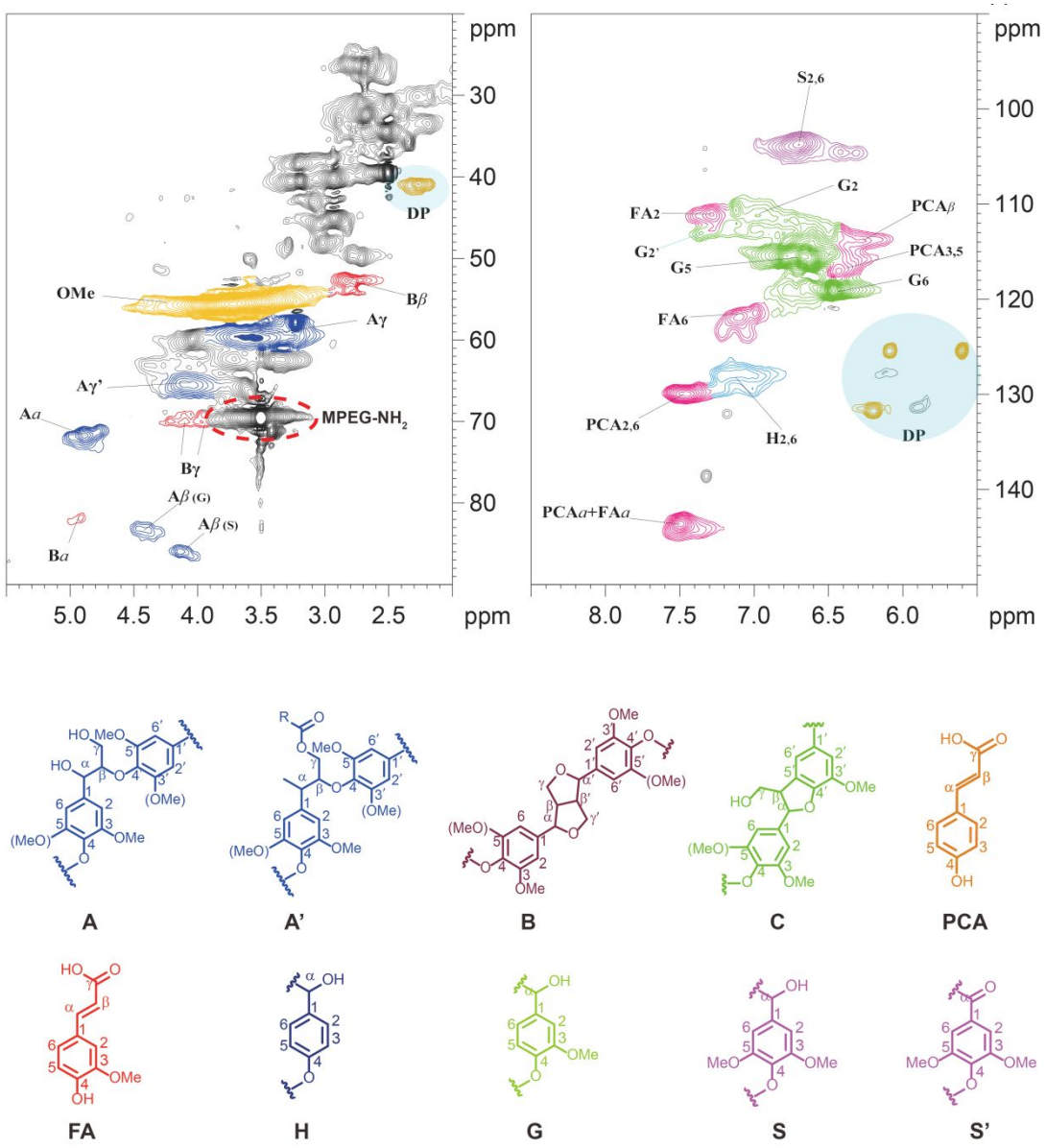

Figure S2. 2D HSQC NMR spectra of modified lignin.

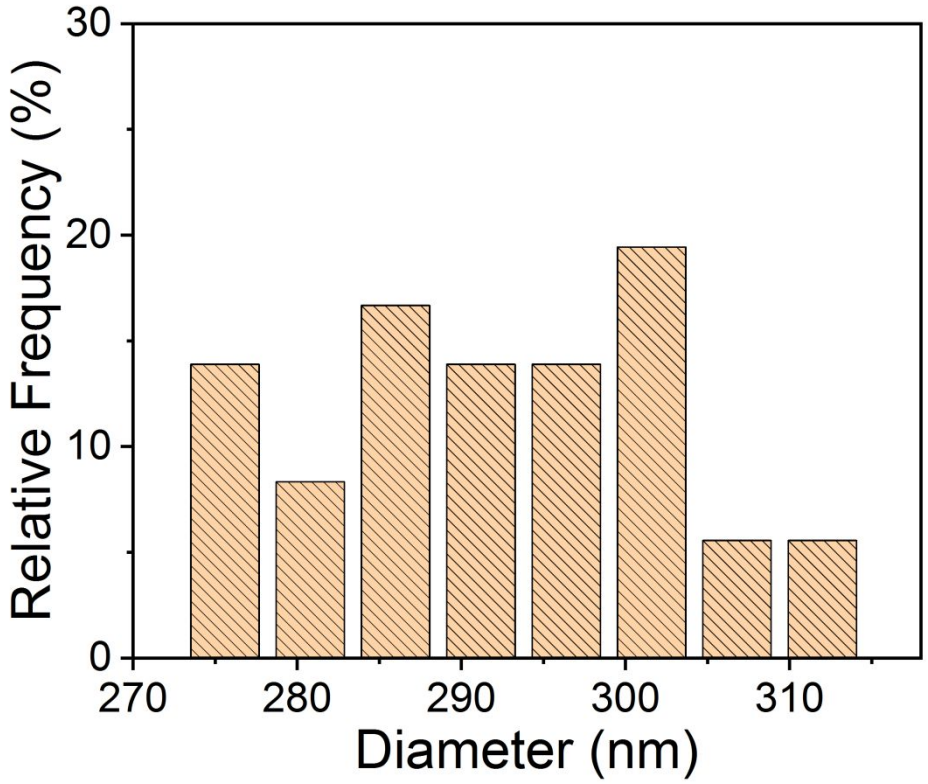

Figure S3. Particle size histogram of L-H-NPs.

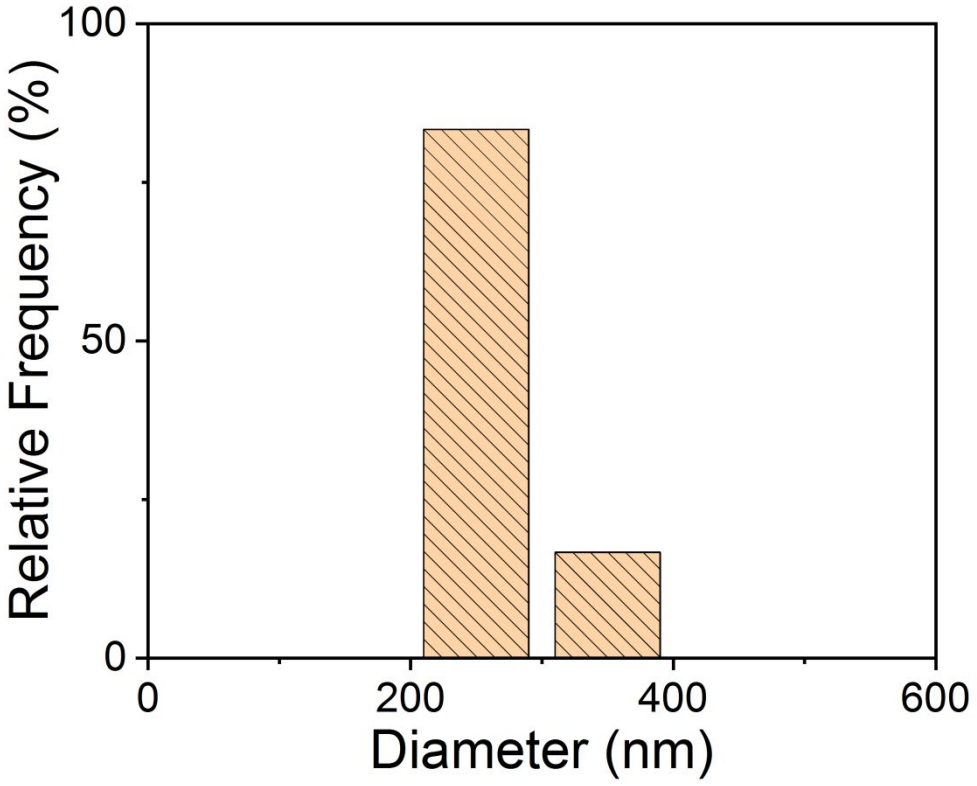

Figure S4. Particle size histogram of L-MS-NPs.

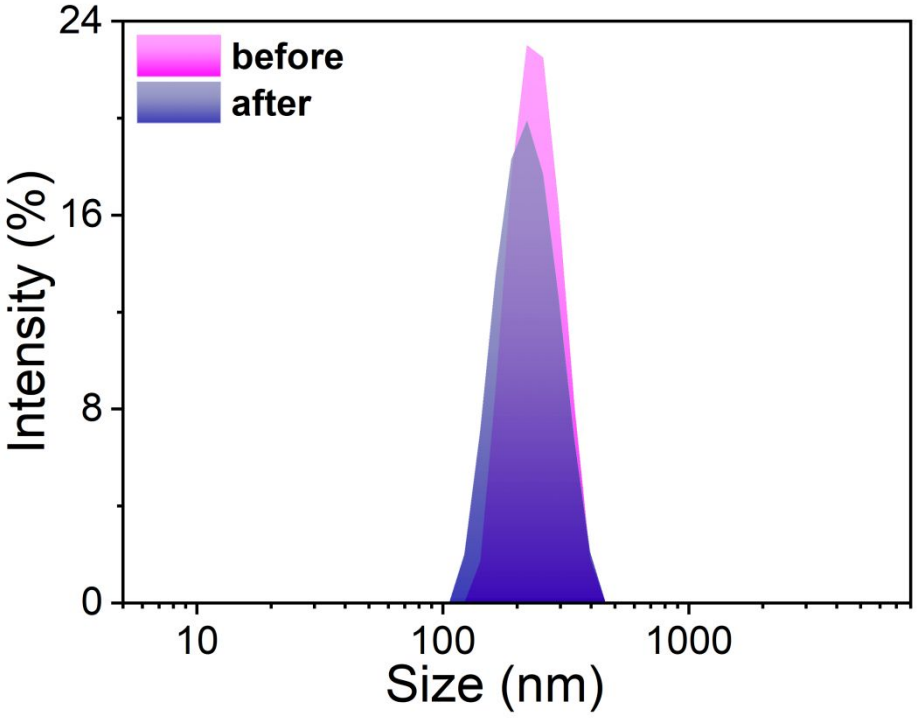

Figure S5. Particle size of L-MS-NPs before and after ultrasonic damage experiment (at 120 W for 5 min).

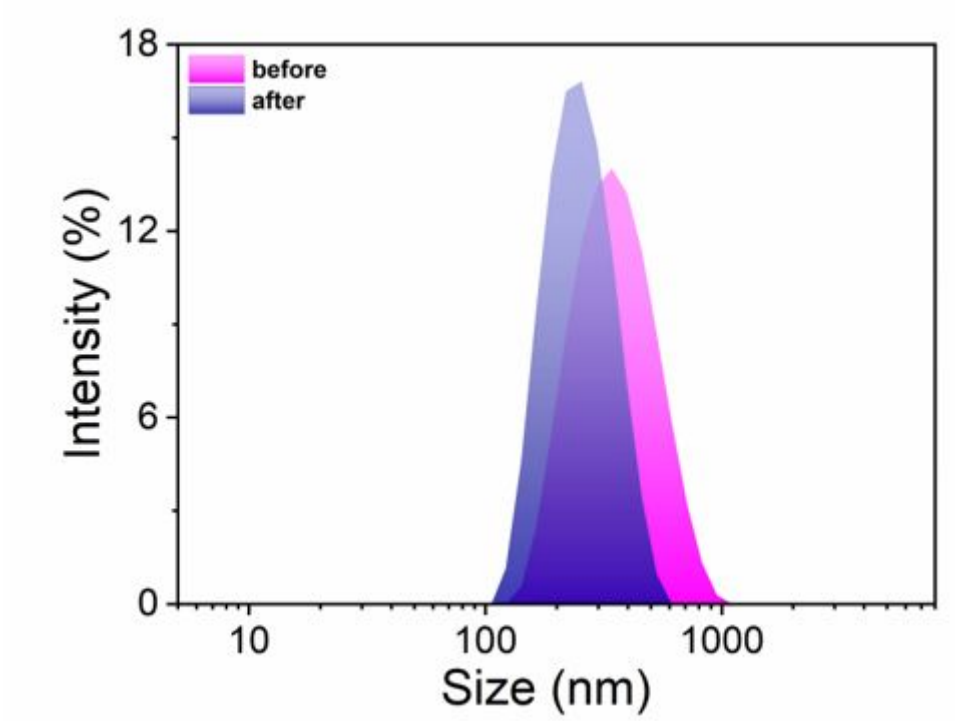

Figure S6. Particle size of L-H-NPs before and after ultrasonic damage experiment (at 120 W for 5 min).

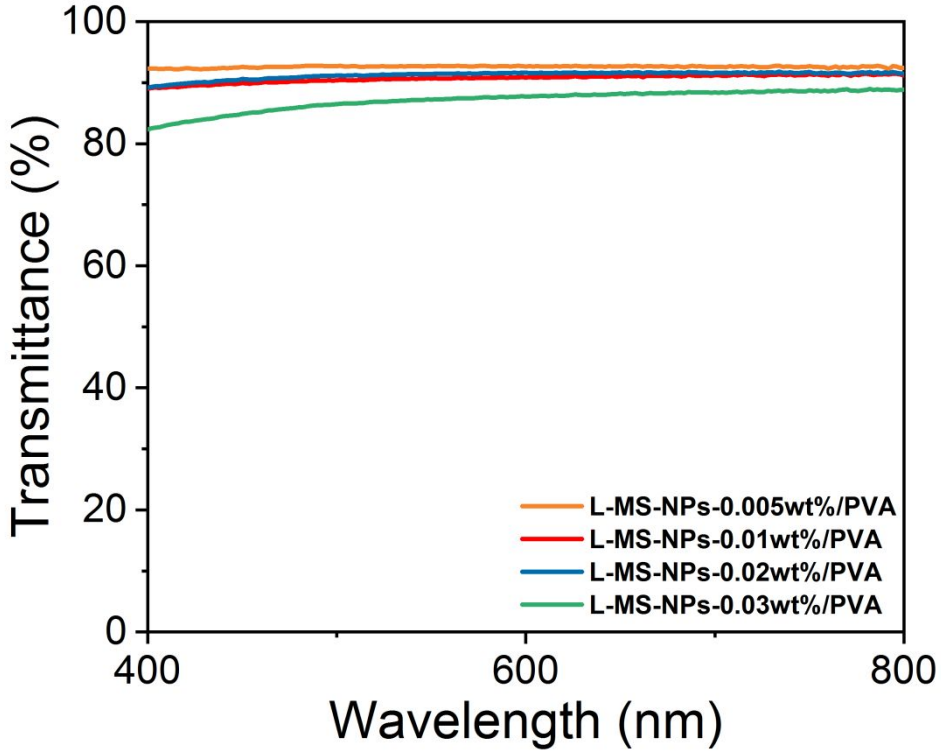

Figure S7. Total forward transmittance of L-MS-NPs/PVA composite films at different amounts of L-MS-NPs.

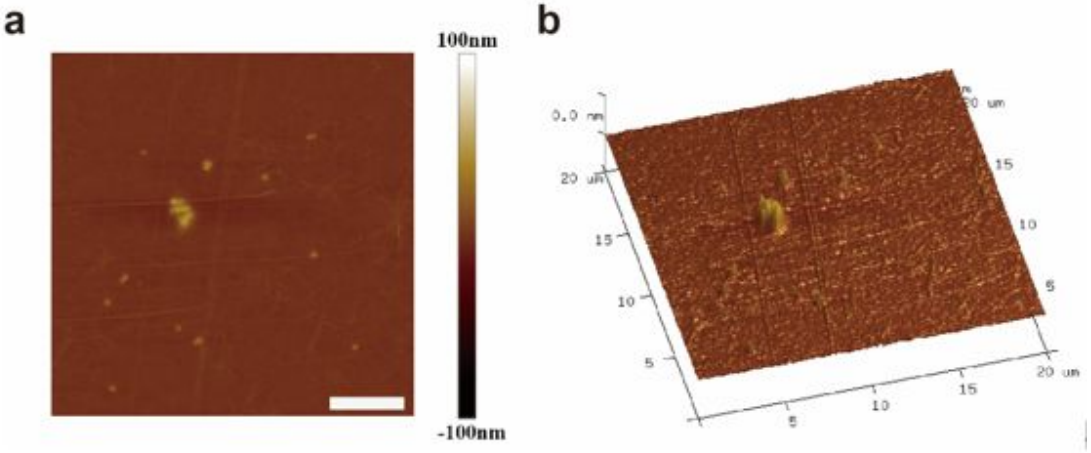

Figure S8. (a) AFM height image and (b) 3D AFM image of L-H-NPs/PVA composite film with scan area of 20×20 μm^2 (scale bar = 4 μm).

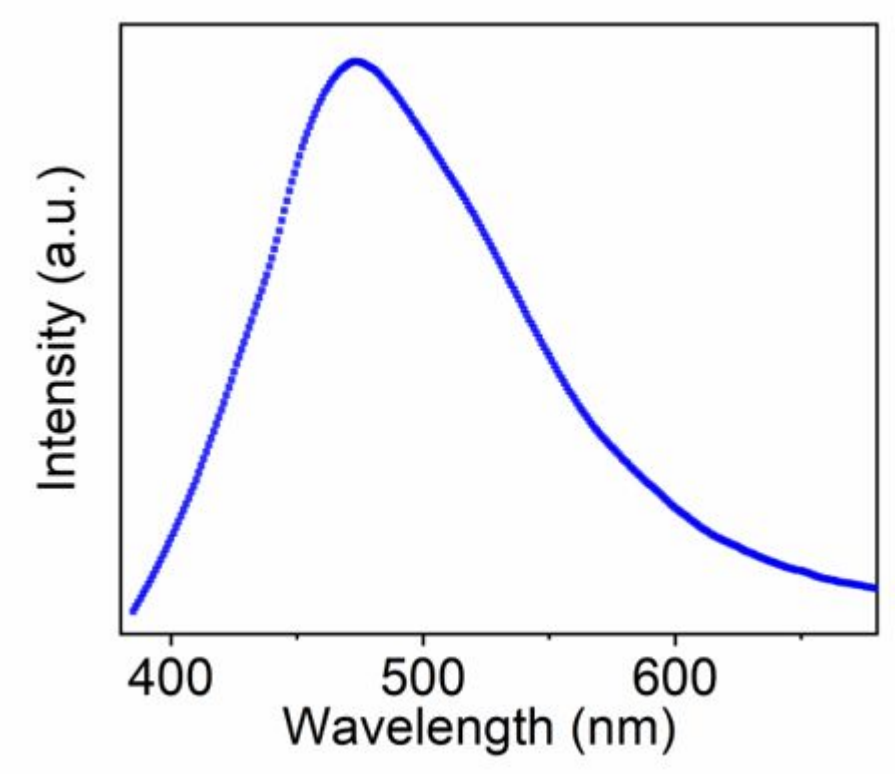

Figure S9. Fluorescence emission of L-MS-NPs, Ex = 365 nm.

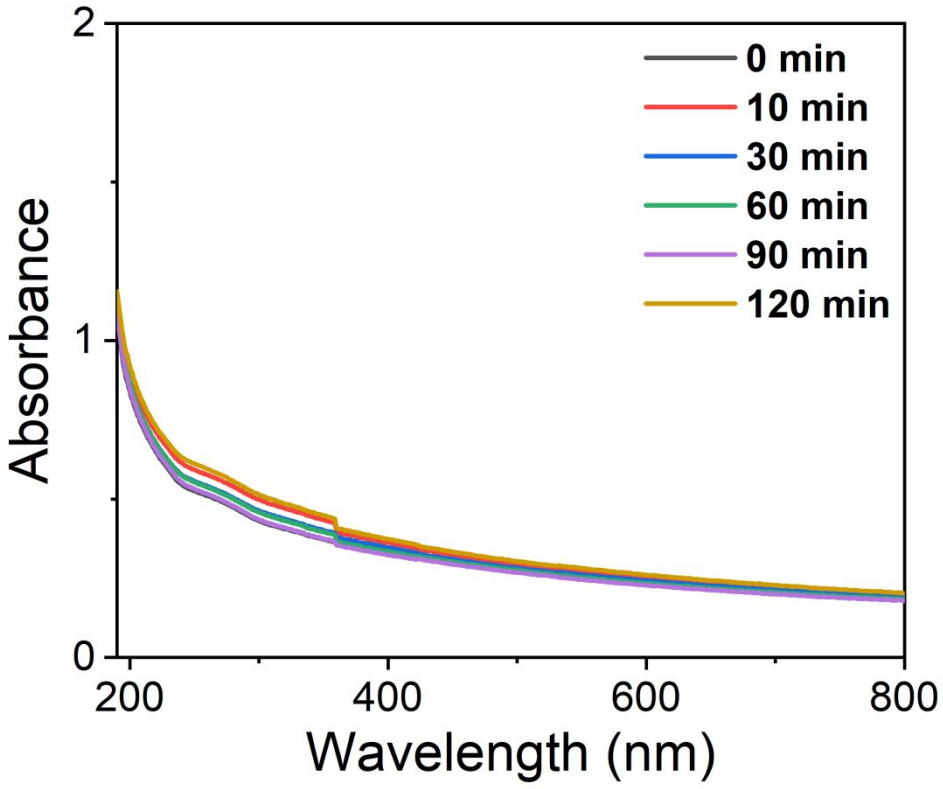

Figure S10. Optical stability of L-MS-NPs-0.01wt%/PVA composite film (under standard 1 sun irradiation, 100 mW/cm^2, 2 h).

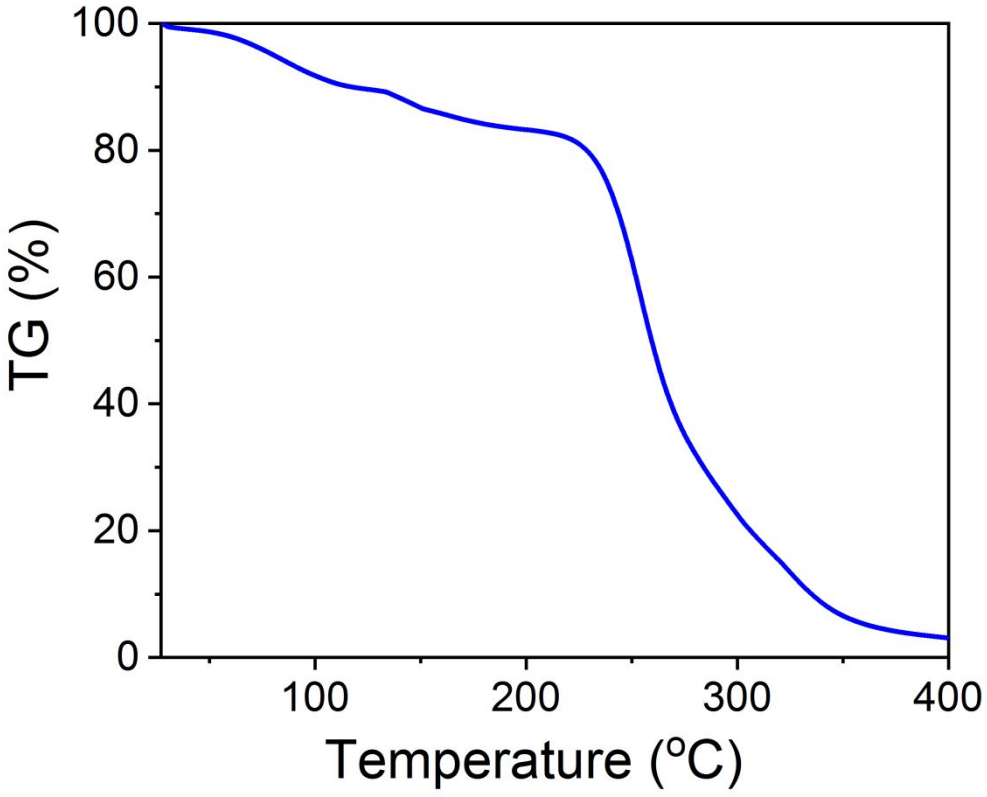

Figure S11. TG curve of L-MS-NPs-0.01wt%/PVA composite film.

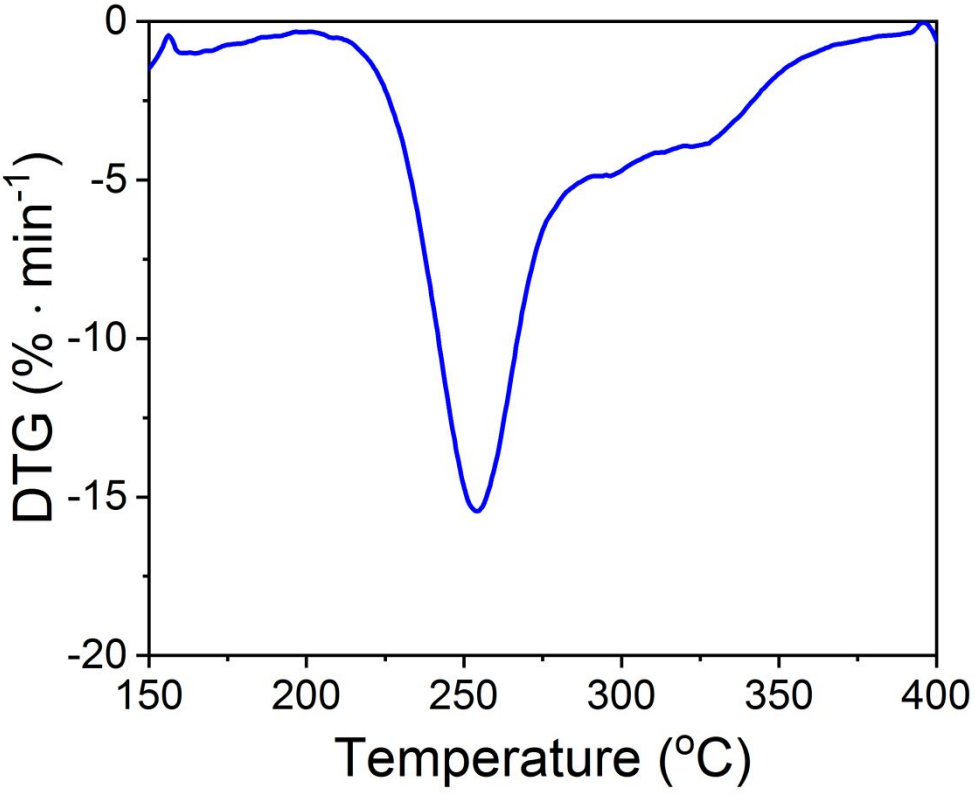

Figure S12. DTG curve of L-MS-NPs-0.01wt%/PVA composite film.

The power conversion efficiency (PCE) was calculated using **Equation S1**:

$$\mathrm{PCE} = \frac{I_{SC} \times V_{OC} \times FF}{P_{in}}$$

where I_{SC} is the short-circuit current, V_{OC} is the open-circuit photovoltage, FF is the fill factor, P_{in} is the incident light power. The external quantum efficiency (EQE) was calculated using **Equation S2**:

$$\mathrm{EQE} = \frac{N_e}{N_p} \times 100\%$$

where N_e is the number of external circuit electrons, N_p is the number of incident monochromatic photon.