Electronic Supplementary Information

Eco-friendly colorful particleboards based on metal-ligand coordination

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1. Supplementary Figures

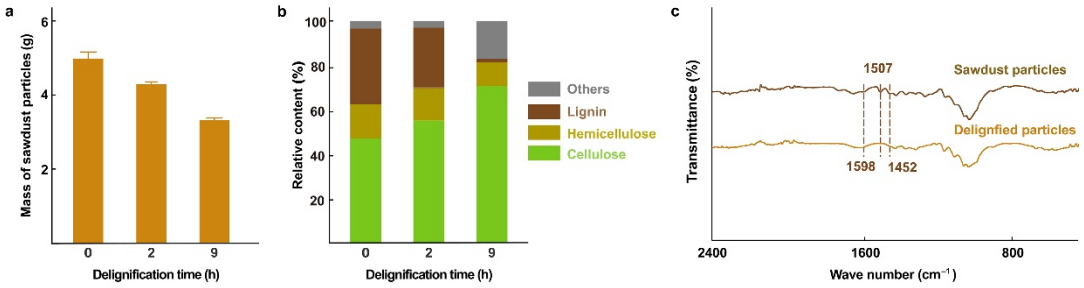

Fig. S1 (a) Correlation between the mass of sawdust particles and delignification time, illustrating a gradual decrease in mass with increasing duration. **(**b) Chemical compositional analysis of the relative content of cellulose, hemicellulose, and lignin throughout the delignification process, showing a decrease in lignin content as the duration increases. (c) Fourier transform infrared (FTIR) spectra of natural and delignified sawdust particles showing the absence of lignin-specific infrared bands (aromatic skeletal vibrations) at 1,598, 1,507 and 1,452 cm^{-1} in delignified samples.

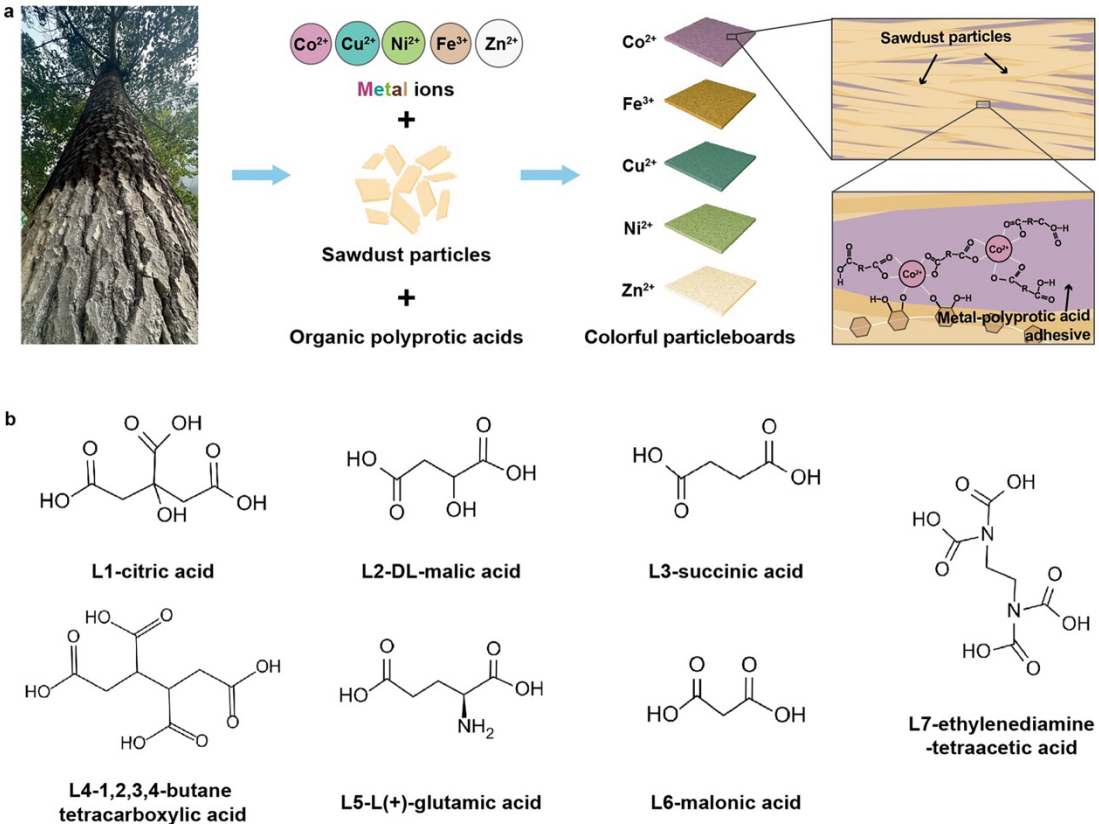

Fig. S2 (a) Design of colorful particleboards utilizing organic polyprotic acids and metal ions as adhesives to bind delignified sawdust particles, followed by fabrication through hot-pressing. (b) Molecular structures of the polyprotic acids (L1 to L7) used in the as-prepared particleboards in Fig. 1.

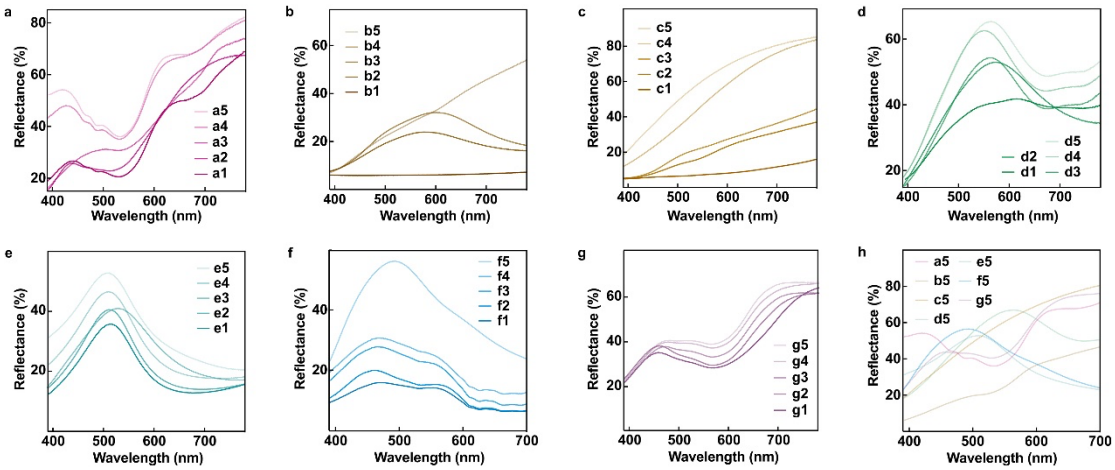

Fig. S3 (a-h) UV–visible (UV–Vis) spectra of the as-prepared colorful particleboards in Fig. 1, with spectra a1 to g5 corresponding to the labels in Fig. 1.

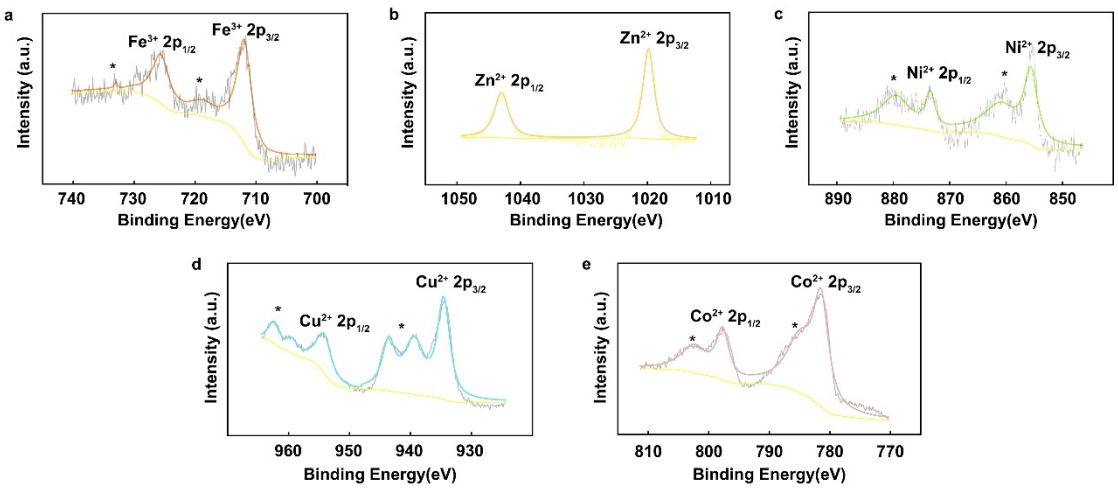

Fig. S4 X-ray photoelectron spectroscopy (XPS) 2*p* spectra of the as-prepared colorful particleboards in Fig. 2a, arranged from left to right. **(**a) Fe^{3+} $2p_{3/2}$ and $2p_{1/2}$ peaks at 711.9 eV and 725.6 eV, respectively;[1] (b) Zn^{2+} $2p_{3/2}$ and $2p_{1/2}$ peaks at 1022.8 eV and 1046.0 eV, respectively;[2] (c) Ni^{2+} $2p_{3/2}$ and $2p_{1/2}$ peaks at 855.6 eV and 873.5 eV, respectively;[3] (d) Cu^{2+} $2p_{3/2}$ and $2p_{1/2}$ peaks at 934.5 eV and 954.2 eV, respectively;[4] (e) Co^{2+} $2p_{3/2}$ and $2p_{1/2}$ peaks at 781.3 eV and 797.7 eV,[5] respectively, along with their respective satellite peaks (marked with *). a.u. arbitrary units.

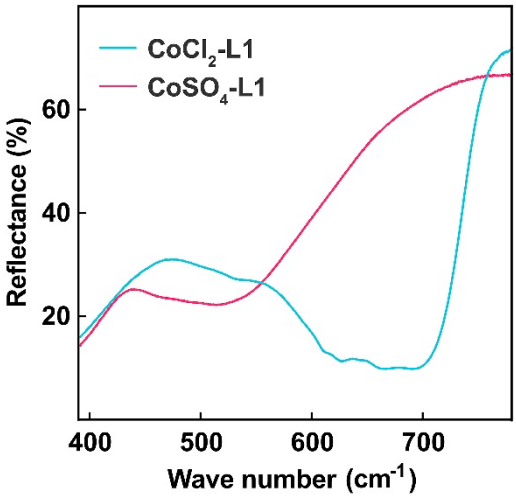

Fig. S5 UV–vis spectra of the as-prepared particleboards, colored using $CoCl_2$ with L1 in tetra-coordinated configuration and $CoSO_4$ with L1 in six-coordinated configuration.

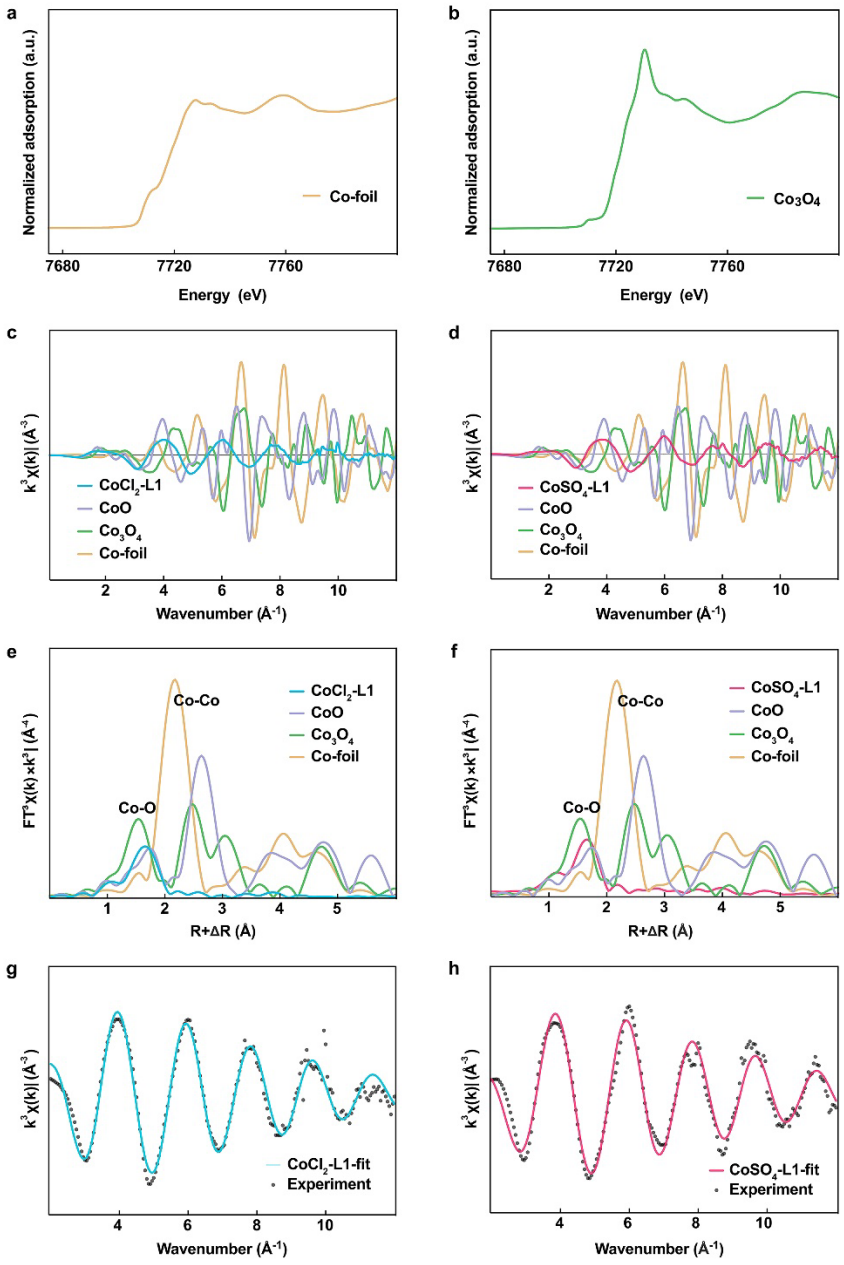

Fig. S6 X-ray absorption analysis of coordination structures in as-prepared colorful particleboards. (a,b) Co K-edge X-ray absorption near-edge structure (XANES) spectra: (a) Co foil standard; (b) Co_3O_4 standard samples. (c,d) K-edge k^3-weighted extended X-ray absorption fine structure (EXAFS) spectra of standard samples and the as-prepared colorful particleboards. (e,f) Fourier transformed (FT) k^3-weighted X(k)-function of the EXAFS spectra showing the coordination of Co-O in the as-prepared colorful particleboards. (g,h) K-edge k^3-weighted EXAFS spectra of the as-prepared colorful particleboards with corresponding fitting curves.

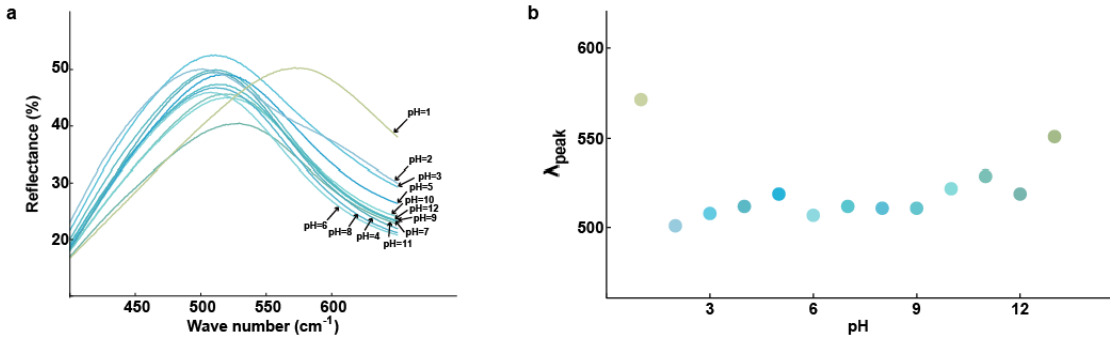

Fig. S7 UV–vis spectra (a) and peaks value (b) of the as-prepared particleboards colored by Cu^{2+} and citric acid with different pH values of the adhesive aqueous solution.

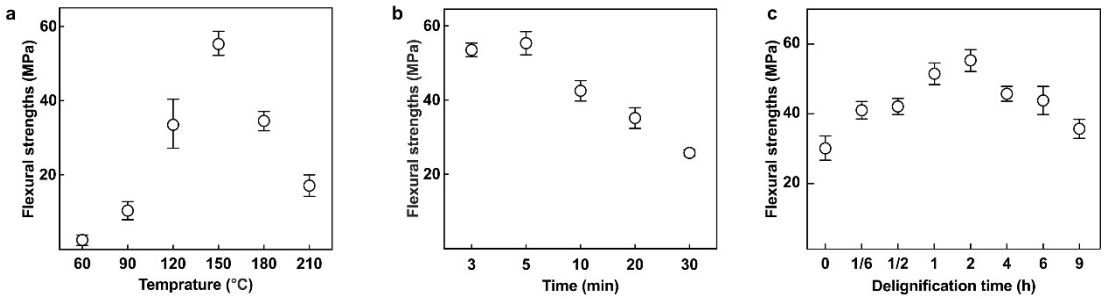

Fig. S8 Regulation of the mechanical properties of the as-prepared particleboards. (a) Correlation between hot-pressing temperature and flexural strength, with the optimal temperature at 150 °C. (b) Correlation between hot-pressing duration and flexural strength, with the optimal pressing duration at 5 minutes. (c) Correlation between delignification time and flexural strength, with the optimal delignification time at 2 hours.

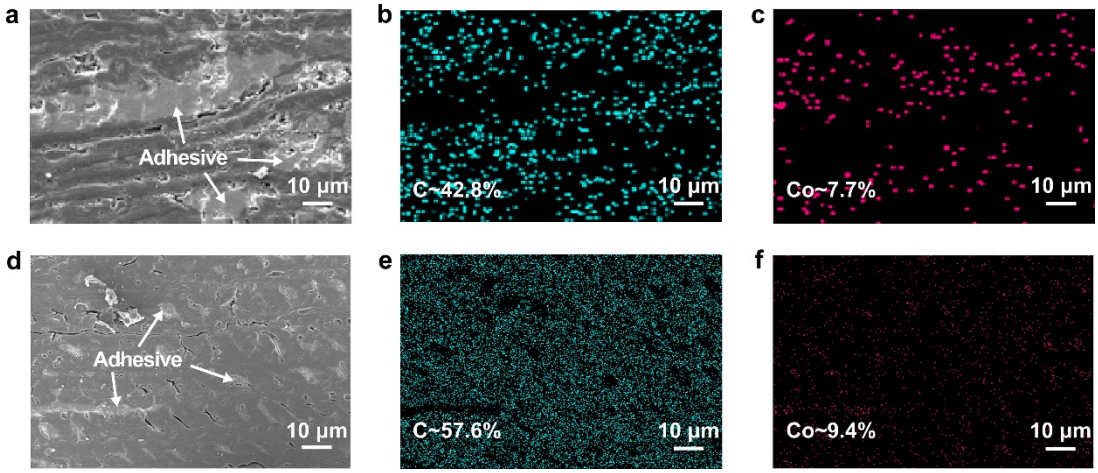

Fig. S9 Microstructure of the as-prepared colorful particleboards. (a-f) Scanning electron microscopy images (a,d), carbon (c) mapping (b,d), and cobalt (Co) mapping (c,f) show the distribution of the adhesive between particles and inside particle lumina.

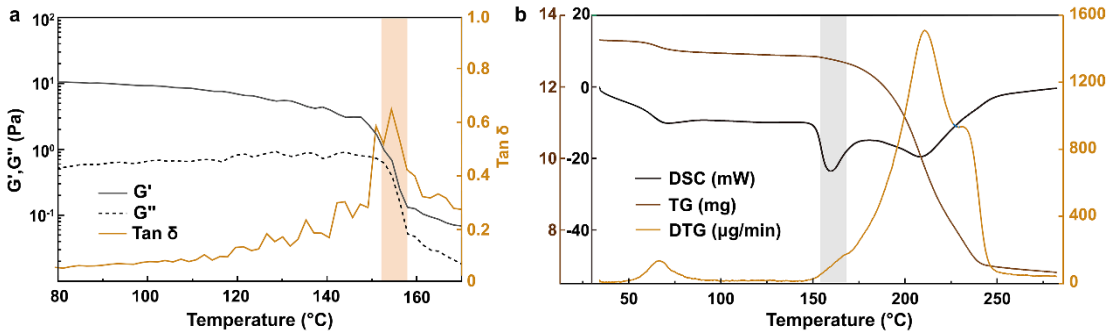

Fig. S10 Heating-induced softening process of the adhesive. (a) Storage modulus (G'), loss modulus (G''), and loss factor (tanδ) of the adhesive during the rheological frequency sweep test. The adhesive exhibited significant softening in the temperature range of 147-157 °C. (b) Differential scanning calorimetry (DSC) results for the adhesive, showing a melting peak between 150-170 °C.

2. Supplementary Tables

Sample	Scattering pair	CN	BD(Å)	σ^2(Å^2)	ΔE_0(eV)	R factor
$CoCl_2$-L1	Co-O	4.3 ± 0.2	2.088 ± 0.006	0.0066 ± 0.0009	2.3 ± 0.6	0.0039
$CoSO_4$-L1	Co-O	6.2 ± 0.6	2.069 ± 0.011	0.0061 ± 0.0015	-2.0 ± 1.2	0.0105

Table S1. EXAFS coordinate environment analysis of various samples. CN: coordination number, BD: bonding distance, σ^2: mean-square disorder, ΔE_0: energy shift, R factor: the goodness of the fit.

3. Supplementary Movies

Movie S1. Micro-structure of the formaldehyde-free colorful sawdust-based particleboard.

References

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