Electronic Supplementary Information

Hydrogenation of α-pinene over platinum nanoparticles reduced and stabilized by sodium lignosulfonate

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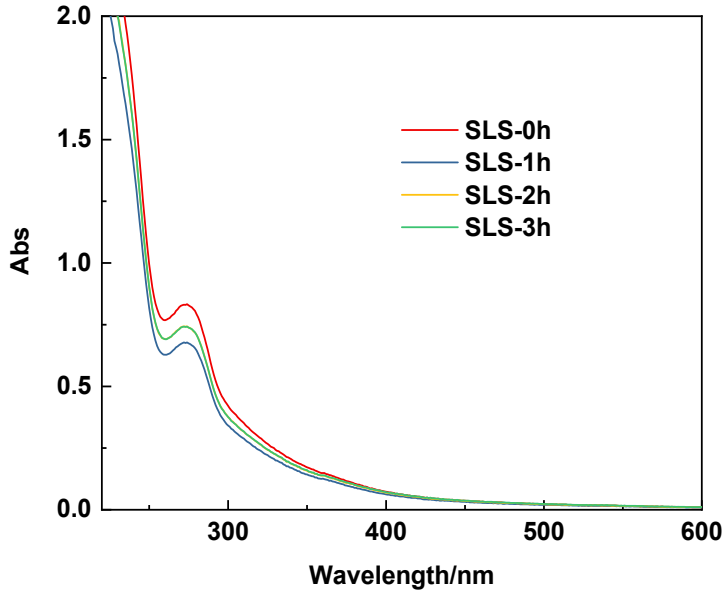


Figure S1. UV-Vis spectra of SLS solution.

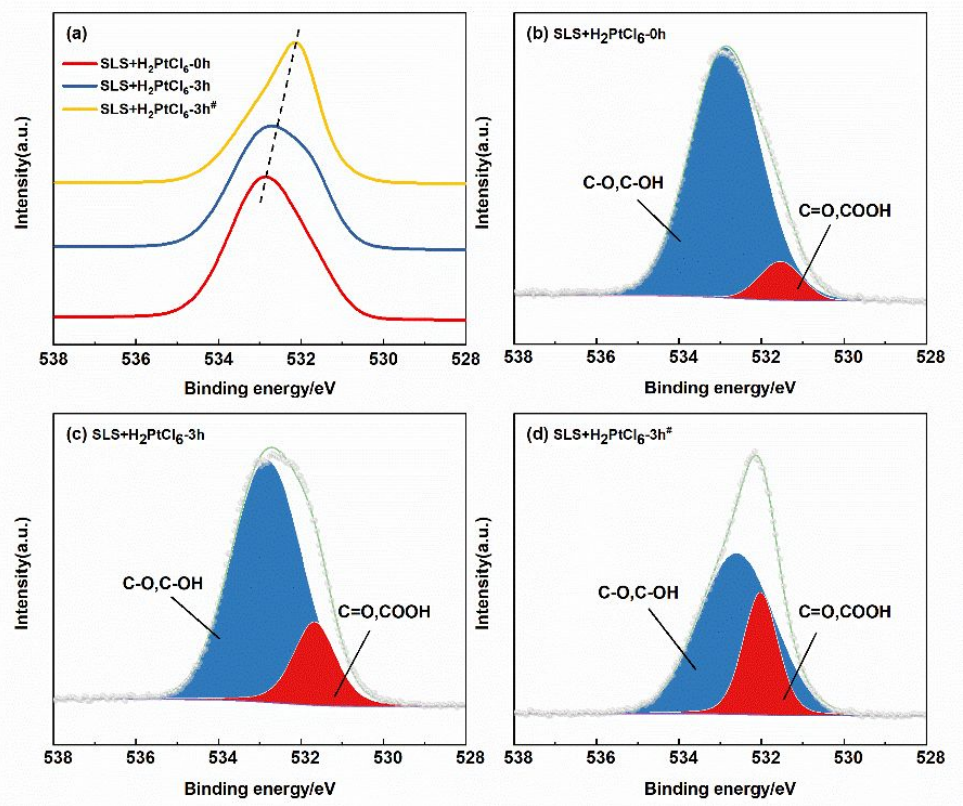


Figure S2. O 1s core-level spectra (a) and fitted O 1s XPS spectra for SLS+H_2PtCl_6-0h (b), SLS+H_2PtCl_6-3h (c) and SLS+H_2PtCl_6-3h$^{\#}$ (d).

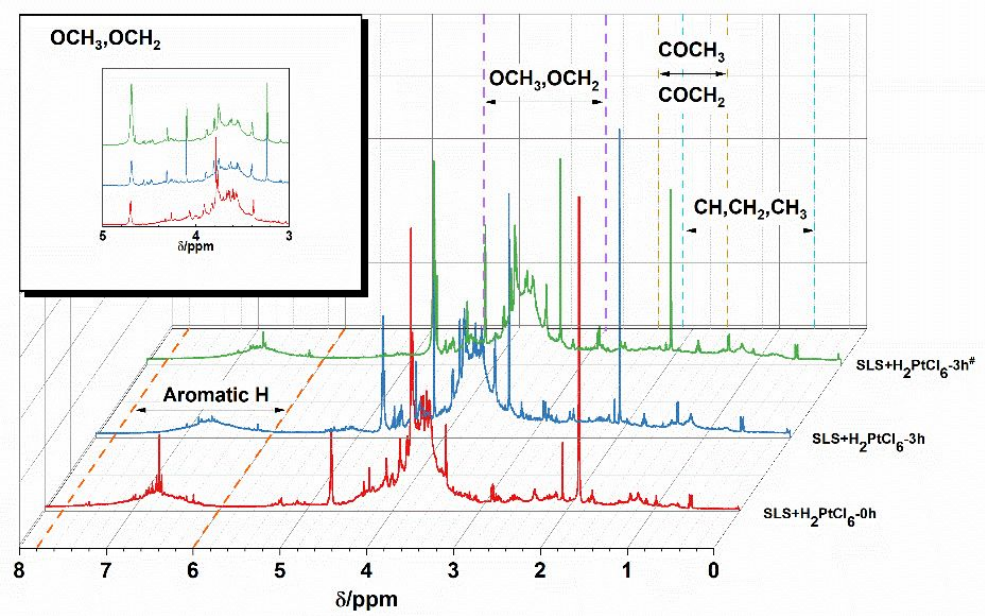


Figure S3. ^{1}H NMR spectra of SLS+H_2PtCl_6-0h, SLS+H_2PtCl_6-3h and SLS+H_2PtCl_6-3h$^{\#}$.

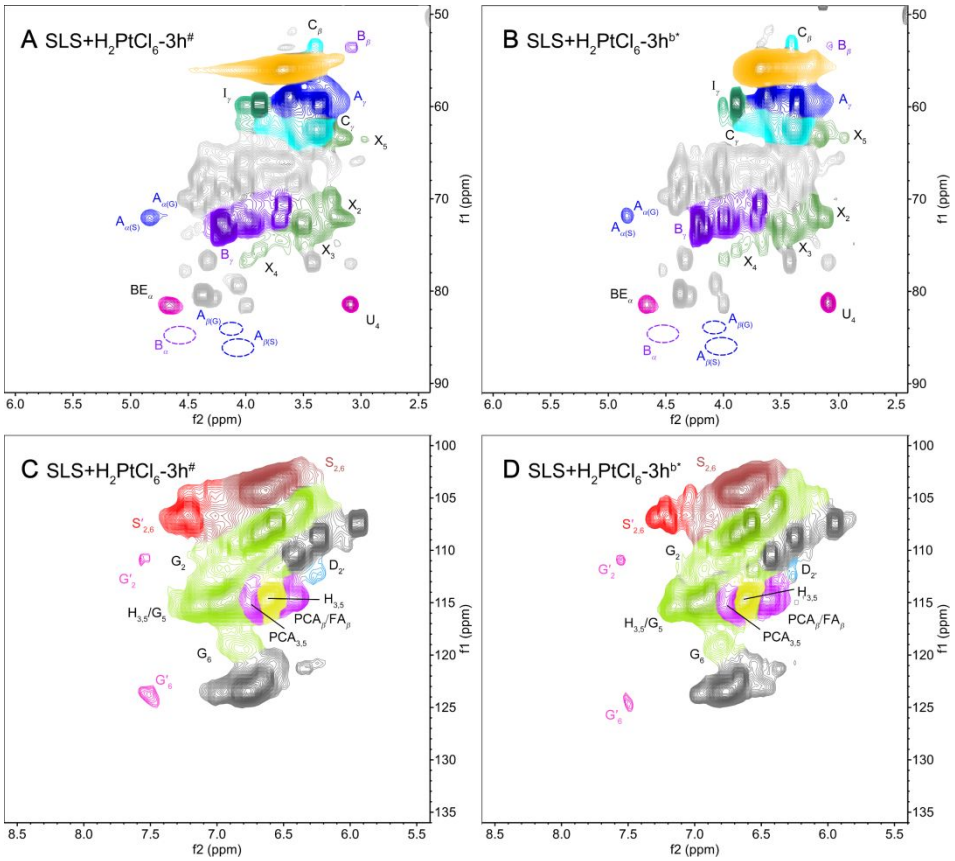


Figure S4. Side-chain (A, B) and aromatic regions (C, D) in the 2D HSQC NMR spectra: δ_C/δ_H 50-90/2.5-6.0 and δ_C/δ_H 100-135/5.5-8.5, respectively. (A, C) SLS+H_2PtCl_6-3h$^{\#}$; (B, D) SLS+H_2PtCl_6-3h^{b*}.

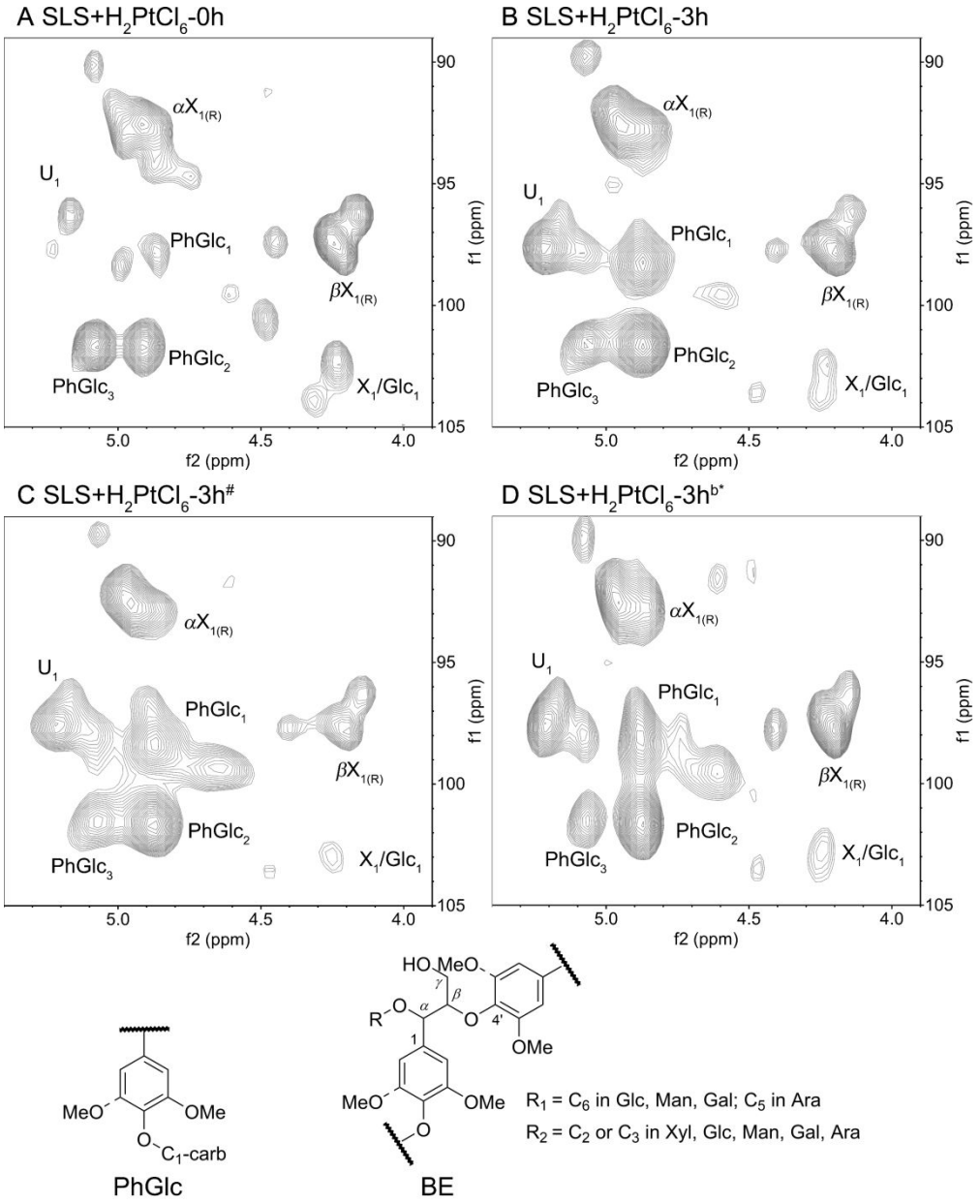


Figure S5. Carbohydrate anomeric regions (δ_C/δ_H 90-105/3.9-5.4) of 2D HSQC NMR spectra of the (A) SLS+H_2PtCl_6-0h, (B) SLS+H_2PtCl_6-3h, (C) SLS+H_2PtCl_6-3h$^{\#}$ and (D) SLS+H_2PtCl_6-3h^{b*}. Assignments of the carbohydrate signals are listed in Table S3.

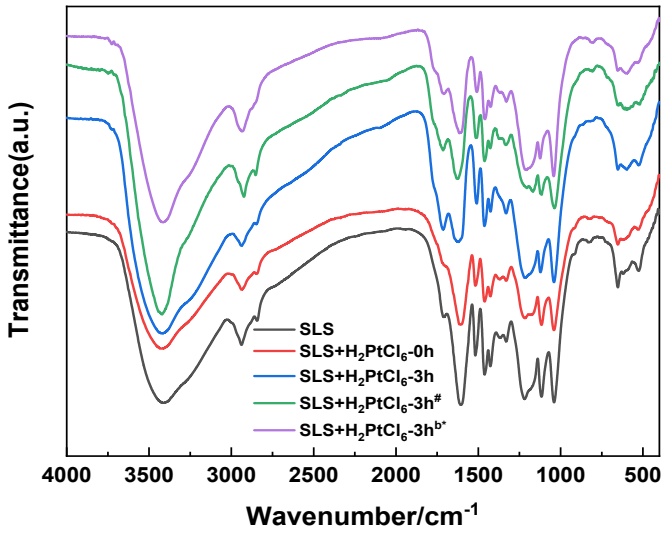


Figure S6. FT-IR spectra of various catalyst samples.

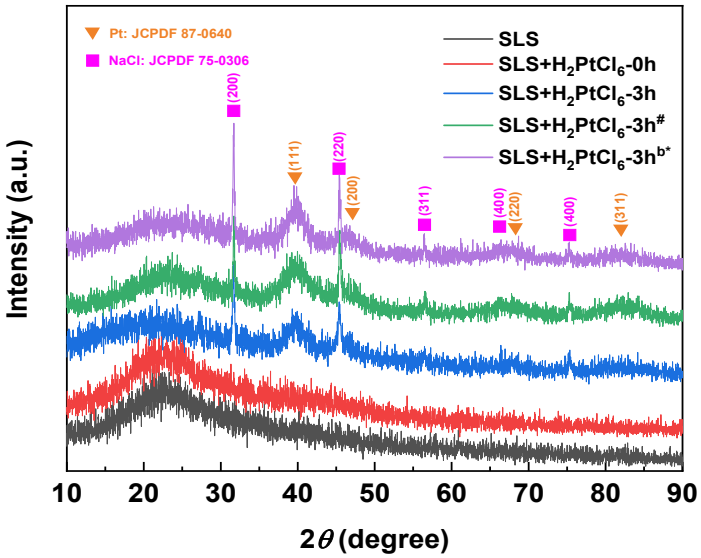


Figure S7. XRD patterns of various catalyst samples.

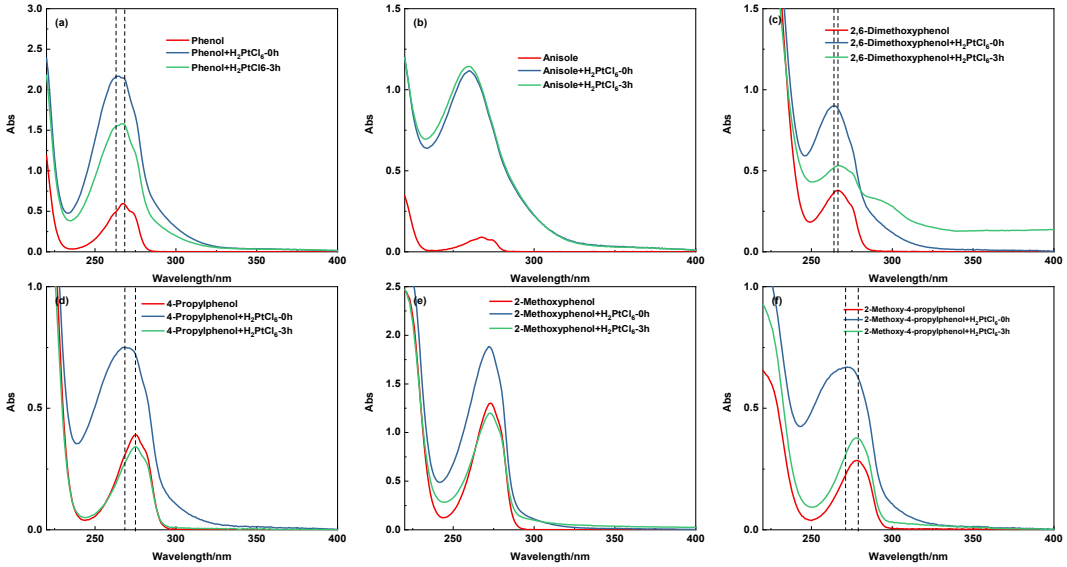


Figure S8. Capability of phenol (a), anisole (b), 2,6-dimethoxyphenol (c), 4-propylphenol (d), methoxyphenol (e) and 2-methoxy-4-propylphenol (f) to reduce H_2PtCl_6.

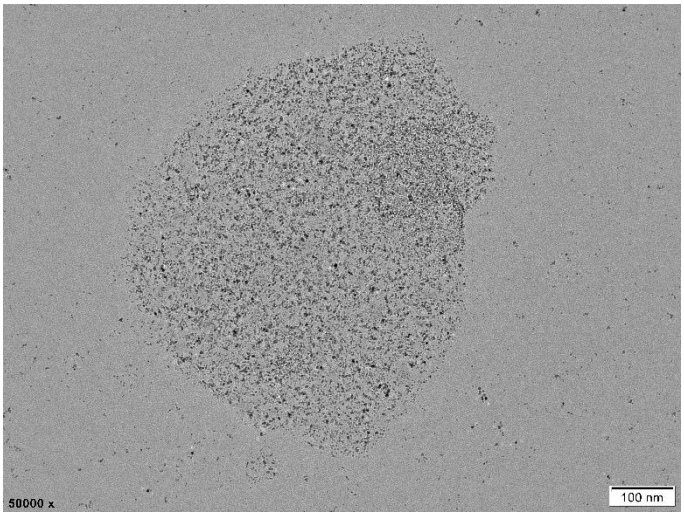


Figure S9. TEM image of SLS+H_2PtCl_6-3h (scale bar 100 nm).

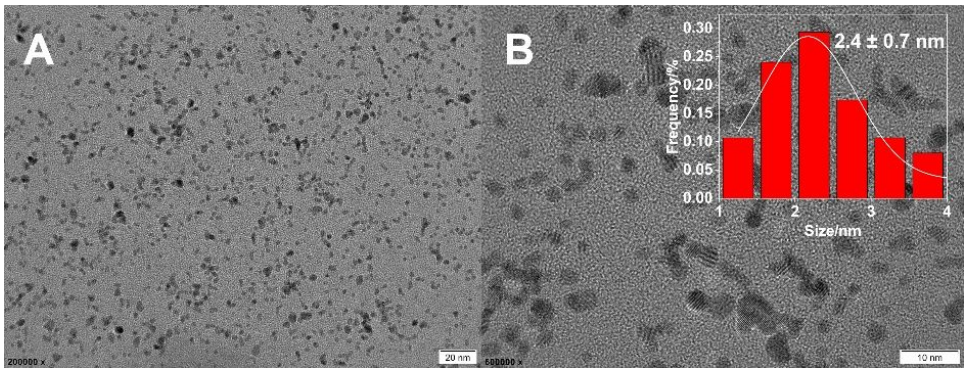


Figure S10. TEM images (A) and Particle Size Distribution (PSD) (B) of the Pt NPs catalyst system after 5 runs.

Table S1. Subpeak area fractions of C 1s and O 1s.

Sample Description	Relative Area/% (Binding energy/eV) of C 1s Peaks			C_3/C_2	Relative Area/% (Binding energy/eV) of O 1s Peaks		O_1/O_2
	C_1(C-C/C=C)	C_2(C-O)	C_3(C=O)		O_1(C=O)	O_2(C-O)	
SLS+H_2PtCl_6-0h	35.39/21.24 (284.7/285.1)	39.61 (286.3)	3.76 (288.5)	0.09	8.26 (531.5)	91.74 (532.6)	0.09
SLS+H_2PtCl_6-3h	43.43/26.06 (284.7/285.1)	24.67 (286.4)	5.84 (288.8)	0.24	19.36 (531.7)	80.64 (532.8)	0.24
SLS+H_2PtCl_6-3h$^{\#}$	51.71/31.03 (284.7/285.3)	12.41 (286.3)	4.85 (288.9)	0.39	28.06 (532.0)	71.94 (532.6)	0.39

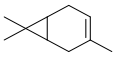
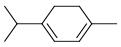
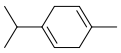
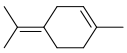
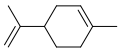
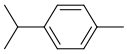
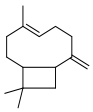
Table S2. Assignment of the ^{1}H-^{13}C cross-signals in the 2D HSQC NMR spectra of SLS+H_2PtCl_6-0h, SLS+H_2PtCl_6-3h, SLS+H_2PtCl_6-3h$^{\#}$ and SLS+H_2PtCl_6-3h^{b*}.

Lable	δ_C/δ_H	Assignment
-OCH_3	55.6/3.68	C-H in methoxyls
A_γ	59.8/3.35 and 3.72	C_γ-H_γ in γ-hydroxylated β-O-4′ substructures
$A_{\alpha(G)}$	71.8/4.68	C_α-H_α in β-O-4′ substructures linked to G-unit
$A_{\alpha(S)}$	72.1/4.85	C_α-H_α in β-O-4′ substructures linked to S-unit
$A_{\beta(G)}$	84.1/4.22	C_β-H_β in β-O-4′ substructures linked to G-unit
$A_{\beta(S)}$	86.2/4.09	C_β-H_β in β-O-4′ substructures linked to S-unit
B_α	85.5/4.61	C_α-H_α in β-β′ resinol substructures
B_β	53.5/3.08	C_β-H_β in β-β′ resinol substructures
B_γ	71.2/3.72 and 4.20	C_γ-H_γ in β-β′resinol substructures
C_α	87.6/5.40	C_α-H_α in phenylcoumaran substructures
C_β	53.5/3.41	C_β-H_β in phenylcoumaran substructures
C_γ	62.7/3.83	C_γ-H_γ in phenylcoumaran substructures
D_α	81.2/5.10	C_α-H_α in spirodienone substructures
D_β	59.3/2.77	C_β-H_β in spirodienone substructures
$D_{\beta'}$	78.5/4.18	C_β-$H_{\beta'}$ in spirodienone substructures
$D_{2'}$	112.7/6.25	$C_{2'}$-$H_{2'}$ in spirodienone substructures
$D_{6'}$	121.0/6.09	$C_{6'}$-$H_{6'}$ in spirodienone substructures
I_γ	61.6/4.03	C_γ-H_γ in cinnamyl alcohol end-groups
$S_{2,6}$	104.2/6.66	$C_{2,6}$-$H_{2,6}$ in etherified syringyl units (S)
$S_{2,6'}$	106.3/7.27	$C_{2,6}$-$H_{2,6}$ in oxidized (C_α=O) syringyl units
G'_2	110.9/6.89	C_2-H_2 in guaiacyl units (G, Non-phenolic G)
G_2	110.5/7.55	C_2-H_2 in oxidized (C_α=O) guaiacyl units
G_2	107.4/6.63	C_2-H_2 in guaiacyl units (G, Phenolic G)
G_5	114.9/6.95	C_5-H_5 in guaiacyl units
G_6	118.9/6.78	C_6-H_6 in guaiacyl units
G'_6	123.9/7.55	C_6-H_6 in oxidized (C_α=O) guaiacyl units
PCA_β	114.4/6.43	C_β-H_β in *p*-coumarate
$PCA_{3,5}$	115.1/6.86	$C_{3,5}$-$H_{3,5}$ in *p*-coumarate
PCA_α	143.7/7.60	C_α-H_α in *p*-coumarate
$H_{2,6}$	127.7/7.13	$C_{2,6}$-$H_{2,6}$ in p-hydroxybenzoate substructures
FA_6	122.7/7.17	C_6-H_6 in ferulate

Table S3. Assignment of the associated carbohydrate ^{1}H-^{13}C cross-signals in the 2D HSQC NMR spectra of SLS+H_2PtCl_6-0h, SLS+H_2PtCl_6-3h, SLS+H_2PtCl_6-3h$^{\#}$ and SLS+H_2PtCl_6-3h^{b*}.

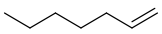
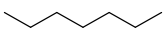
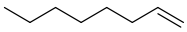
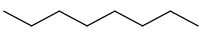
Lable	δ_C/δ_H	Assignment
X_2	72.2/3.13	C_2-H_2 in β-$_D$-xylopyranoside
X_3	73.5/3.42	C_3-H_3 in β-$_D$-xylopyranoside
X_4	75.4/3.87	C_4-H_4 in β-$_D$-xylopyranoside
X_5	63.2/3.18	C_5-H_5 in β-$_D$-xylopyranoside
BE_α	81.7/4.68	C_α-H_α in benzyl ether LCC structures anomeric correlations (C_1-H_1)
U_4	81.3/3.10	C_4-H_4 in 4-*O*-methyl-α-$_D$-GlcUA
$\alpha X_{1(R)}$	92.5/4.91	(1→4)-α-$_D$-xylopyranoside (R)
$\beta X_{1(R)}$	97.4/4.25	(1→4)-β-$_D$-xylopyranoside (R)
U_1	97.2/5.20	4-*O*-methyl-α-$_D$-GlcUA
$PhGlc_1$	98.2/4.88	phenyl glycoside linkages
$PhGlc_2$	101.8/4.90	phenyl glycoside linkages
$PhGlc_3$	101.7/5.07	phenyl glycoside linkages
X_1/Glc_1	103.9/4.32	β-$_D$-xylopyranoside/β-$_D$-glucopyranoside

Table S4. Hydrogenation of terpenes catalyzed by SLS-stabilized Pt NPs.

Substrates	Structural formulas	Conversion/%	Distribution of products %
β-pinene		100	82.12 17.88
3-carene		100	100
α-terpinene		92.24	26.96 73.04
γ- terpinene		92.78	33.22 66.78
terpinolene		99.38	53.54 46.46
limonene		98.43	43.16 56.84
p-cymene		4.43	47.19 52.81
β-caryophyllene		97.14	37.42 31.22 31.36
longifolene		100	5.15 36.25 58.59

Reaction conditions: $n_{(cat.)} : n_{(\alpha\text{-pinene})} = 1 : 400$, 10 mmol α-pinene, 1 MPa H_2, 70 °C, 2.0 h.

Table S5. Hydrogenation of other alkenes catalyzed by SLS-stabilized Pt NPs.

Substrates	Conversion/%	Products	Selectivity%
	42.43		100
	0.93		100
	100		100
	100		100
	100		100
	99.84		100

Reaction conditions: $n_{(cat.)}$: $n_{(\alpha\text{-pinene})}$ = 1 : 400, 10 mmol α-pinene, 1 MPa H_2, 70 °C, 2.0 h.