

Supplementary Material

Feasibility of Combining Novel LacN with Traditional Enzyme Immobilization Techniques: Further Enhancement of Enzyme Activity and Stability

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Table S1. Design expert software experiment design parameters.

Number	LacN volume fraction (A)	pH (B)	Reaction time (C)
1	0	1	1
2	0	0	0
3	0	0	0
4	0	-1	1
5	1	-1	0
6	1	0	-1
7	0	0	0
8	-1	-1	0
9	-1	0	1
10	1	1	0
11	0	0	0
12	0	0	0
13	0	-1	-1
14	0	1	-1
15	-1	0	-1
16	1	0	1
17	-1	1	0

Table S2. Box Behnken response surface methodology coding table.

Factor	Condition	Unit	Type	Minimum value	Maximum value	Minimum encoding value	Maximum encoding value	Average value	Std. Dev.
A	LacN volume fraction	%	Numeric	60	80	-1	+1	70	7.07
B	pH		Numeric	5	7	-1	+1	6	0.7071
C	Reaction time	h	Numeric	2	4	-1	+1	3	0.7071

Table S3. Parameter values of different models.

Project	model	F value	P value	R ²	significant
lacN@Cu/nHAP-BC	linear equation	0.0681	0.9759	0.0155	N
	2FI	0.0313	0.9998	0.185	Y
	Quadratic equation	199.42	<0.0001	0.9961	Y
	Higher order equation	144.88	<0.0001	0.9977	Y
lacN@Cu/pHAP-BC	linear equation	12.17	0.0004	0.7373	Y
	2FI	4.72	0.0156	0.7390	Y
	Quadratic equation	230.6	<0.0001	0.9966	Y
	Higher order equation	220.03	<0.0001	0.9985	Y

Table S4. Parameter values under quadratic equation model.

Item	factor	coefficient	degree of freedom	standard deviation	95% confidence interval low value	95% confidence interval high value	VIF
lacN@Cu/nHAP-BC	intercept	0.0994	1	0.0003	0.0986	0.1002	
	A	-0.0002	1	0.0003	-0.0009	0.0004	1
	B	-0.0014	1	0.0003	-0.0021	-0.0008	1
	C	0	1	0.0003	-0.0007	0.0006	1
	AB	0.0003	1	0.0004	-0.0006	0.0012	1
	AC	0.0005	1	0.0004	-0.0004	0.0014	1
	BC	0.0007	1	0.0004	-0.0003	0.0016	1
	A ²	-0.0003	1	0.0004	-0.0012	0.0006	1.01
	B ²	-0.0157	1	0.0004	-0.0166	-0.0148	1.01
	C ²	-0.0002	1	0.0004	-0.0011	0.0006	1.01
lacN@Cu/pHAP-BC	intercept	0.0719	1	0.0003	0.0712	0.0725	
	A	0.0075	1	0.0002	0.007	0.008	1
	B	0.0039	1	0.0002	0.0034	0.0044	1
	C	-0.001	1	0.0002	-0.0015	-0.0005	1
	AB	-0.0004	1	0.0003	-0.0011	0.0003	1
	AC	0.0003	1	0.0003	-0.0005	0.001	1
	BC	-0.0003	1	0.0003	-0.001	0.0004	1
	A ²	0.0008	1	0.0003	0.0001	0.0015	1.01
	B ²	-0.0069	1	0.0003	-0.0076	-0.0062	1.01
	C ²	0.0009	1	0.0003	0.0002	0.0016	1.01

Table S5. Bet parameters of catalyst.

Sample	BET specific surface area	Specific surface area in micropores	External specific surface area	Total pore volume	Micropore volume	Average aperture	Average mesopore diameter
	m ² /g	m ² /g	m ² /g	cm ³ /g	cm ³ /g	nm	nm
lacN@Cu/nHAP- BC	168.9	138.3	30.67	0.0902	0.0545	2.137	16.94
lacN@Cu/pHAP- BC	179.1	137.8	41.25	0.0963	0.0548	2.151	9.95