

Supporting Information

Efficient continuous-flow synthesis of long-chain alkylated naphthalene catalyzed by ionic liquids in a microreaction system

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1. Supplementary Figures

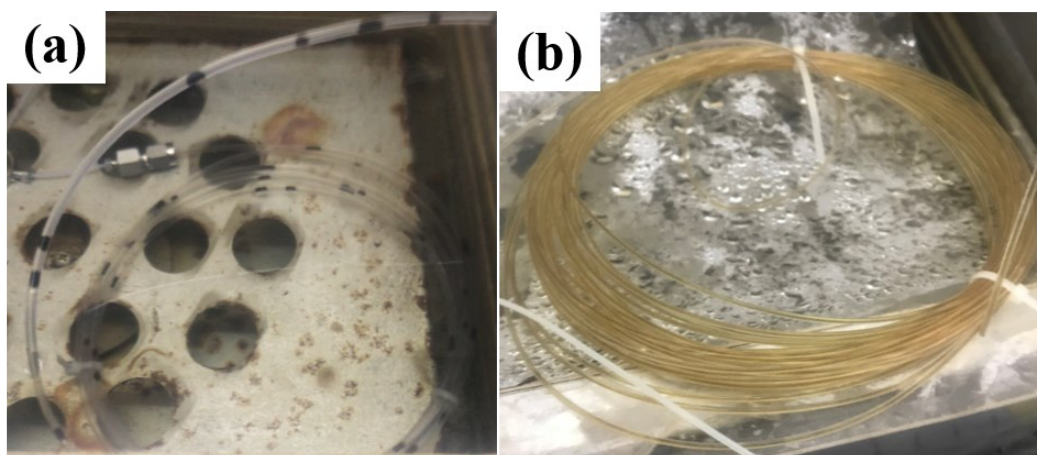


Figure S1. Influence of the delay loop's inner diameter on the dispersion of two phases
(a) 2 mm inner diameter; (b) 0.9 mm inner diameter

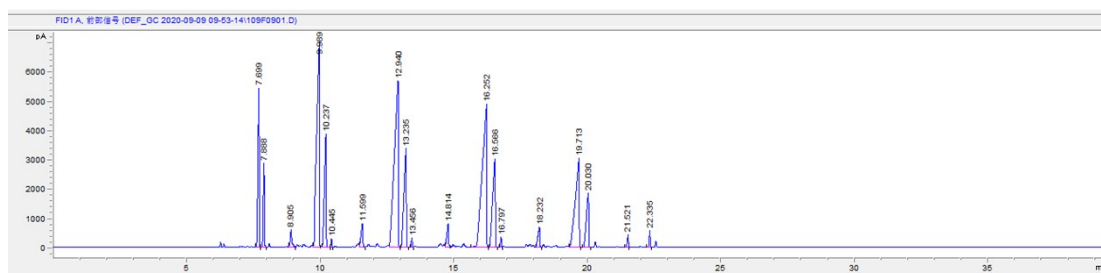


Figure S2. GC profiles for the 1-dodecene alkylation products

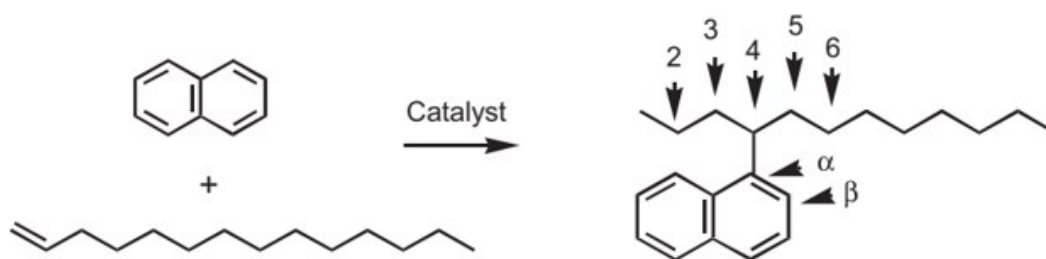


Figure S3. Alkylation reaction between 1-dodecene and naphthalene

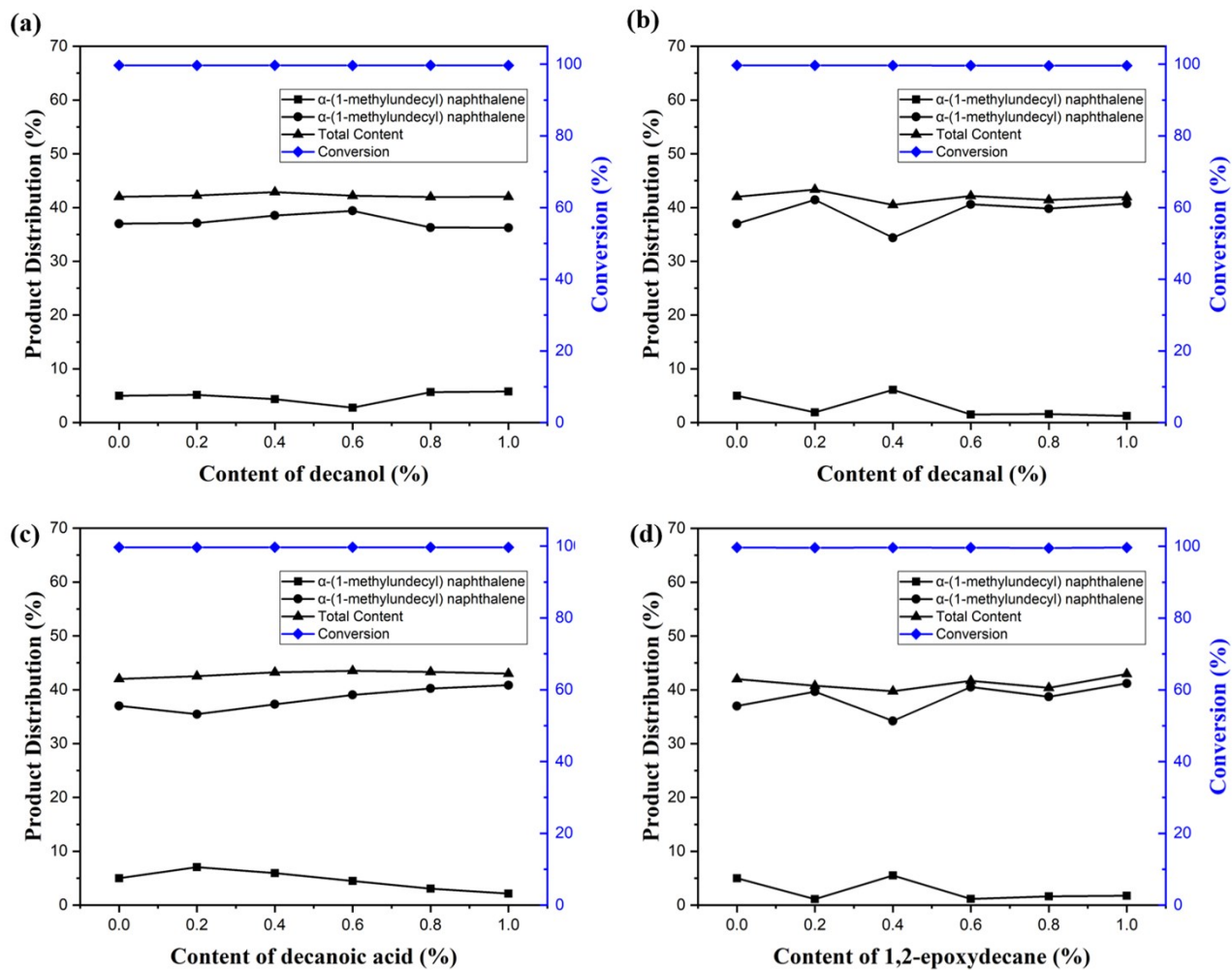


Figure S4. Effects of the content of each kind of oxides on the on the alkylation of 1-dodecene

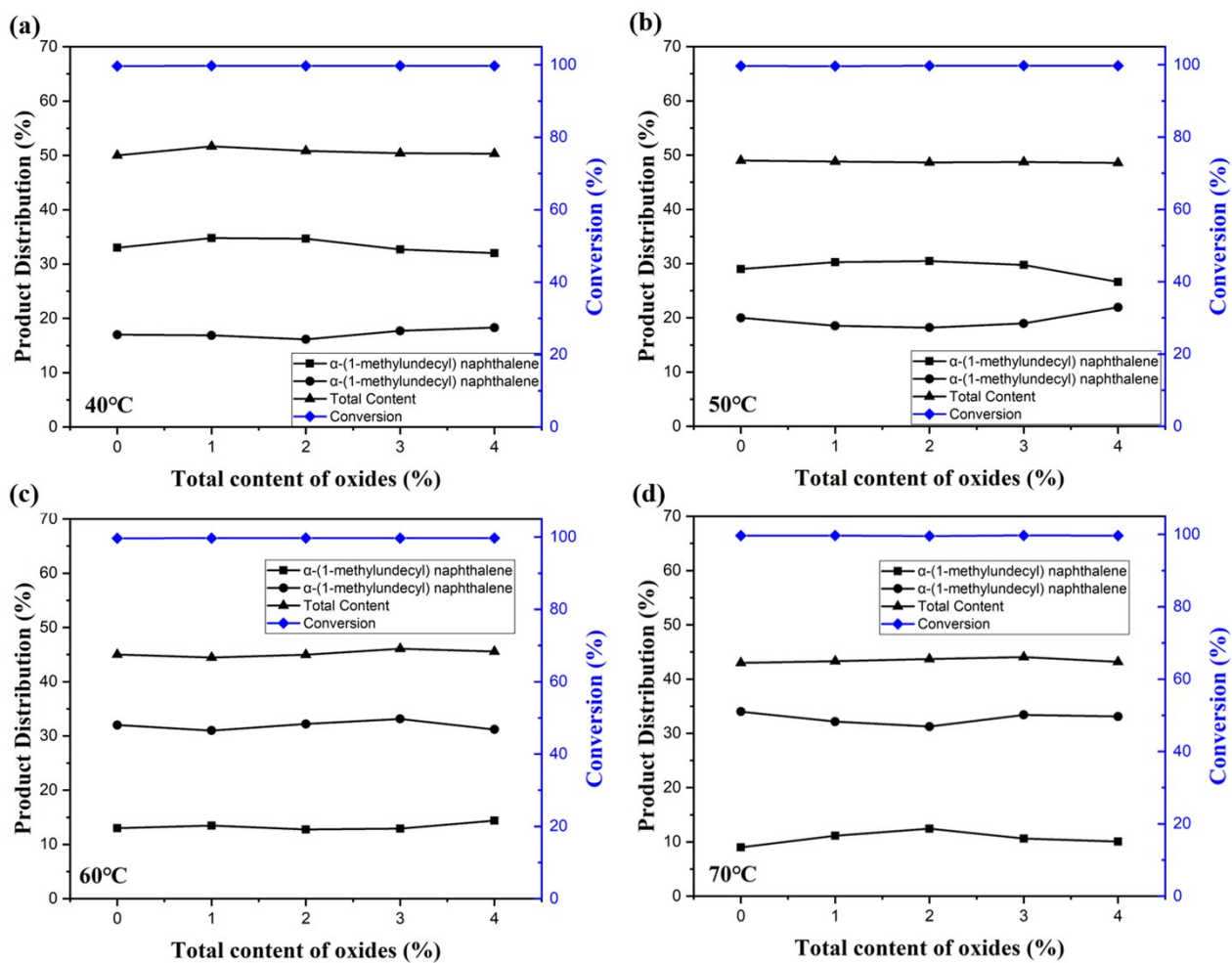


Figure S5. Effects of the total content of oxides on the alkylation of 1-dodecene



Figure S6. GC profiles for the C9~C13 olefins

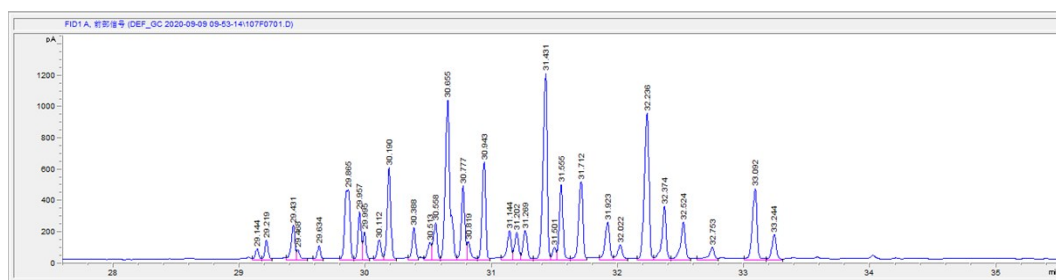


Figure S7. GC profiles for the C9~C13 olefins alkylation products

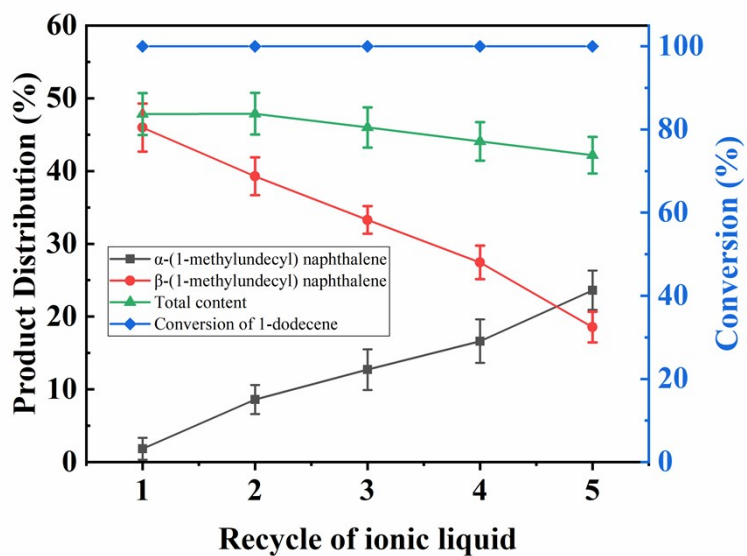


Figure S8. Influence of ionic liquid recycling on the distribution of products

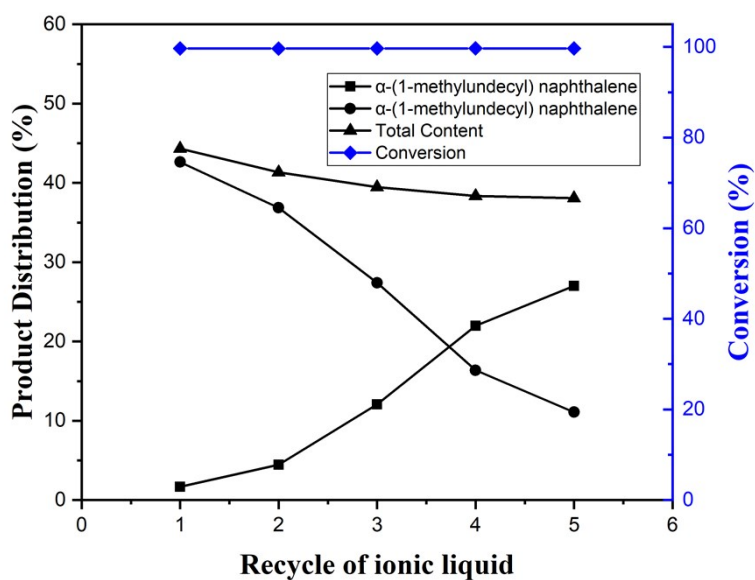


Figure S9. Reuse of ionic liquids at 4% oxides content in 1-dodecene

The flow rates of naphthalene and 1-dodecene were 9 mL/min and 1 mL/min, respectively; the temperature was 70°C; the molar ratio of naphthalene to 1-dodecene was 6:1; the flow rate of ionic liquid was 0.3 mL/min

2. Supplementary Tables

Table S1. Composition of products for the alkylation of 1-dodecene and naphthalene

Peak	Retention time /min	Products	Molecular formula
1	31.186	α - (1-pentylheptyl) naphthalene	C ₂₂ H ₃₂
2	31.251	α - (1-butylloctyl) naphthalene	C ₂₂ H ₃₂
3	31.417	α - (1-propylnonyl) naphthalene	C ₂₂ H ₃₂
4	31.485	β -(1-pentylheptyl) naphthalene	C ₂₂ H ₃₂
5	31.540	β -(1-butyl-octyl) naphthalene	C ₂₂ H ₃₂
6	31.704	α - (1-ethyldecyl) naphthalene β - (1-propylnonyl) naphthalene	C ₂₂ H ₃₂
7	31.917	β - (1-ethyldecyl) naphthalene	C ₂₂ H ₃₂
8	32.237	α - (1-methylundecyl) naphthalene	C ₂₂ H ₃₂
9	32.382	β - (1-methylundecyl) naphthalene	C ₂₂ H ₃₂

Table S2. Retention time of GC-MS for C9~C13 olefines

Peaks	Retention time /min	Components	Molecular formula
1	7.699	1-nonene	C ₉ H ₁₈
2	7.888	nonane	C ₉ H ₂₀
3	9.986	1-decene	C ₁₀ H ₂₀
4	10.237	decane	C ₁₀ H ₂₂
5	12.937	1- undecene	C ₁₁ H ₂₂
6	13.235	undecane	C ₁₁ H ₂₄
7	16.264	1-dodecene	C ₁₂ H ₂₄
8	16.579	dodecane	C ₁₂ H ₂₆
9	19.716	1-tridecene	C ₁₃ H ₂₆
10	20.032	tridecane	C ₁₃ H ₂₈

Table S3. Composition of C9~C13 olefines after normalization

Components	Olefine					Alkane				
	C9	C10	C11	C12	C13	C9	C10	C11	C12	C13
Concentration X_i (wt%)	6.02	17.80	19.73	19.14	10.55	2.70	6.11	6.99	7.27	3.68
$\sum X_i$	73.24					26.76				

Table S4. Productivity of alkylated naphthalene for the alkylation of C9~C13 olefines

Item	Value	Unit
Density of naphthalene (20 wt.% with cyclohexane)	0.80	g/mL
Density of C9~C13 α -olefines	0.75	g/mL
Mass fraction of α -olefines in C9~C13 α -olefines	0.73	1
The average molecular weight of α -olefin in C9~C13 α -olefines	153	g/mol
The average molecular weight of alkylated naphthalene	281	g/mol
Volume flow rate of C9~C13 α -olefines	0.7	ml/min
Conversion rate of α -olefines	0.99	1
Mole flow rate of α -olefines in C9~C13 α -olefines	$0.7*0.75*0.73/153=0.002505$	mol/min
Mass flow rate of alkylated naphthalene	$0.002505*0.99*281=0.697$	g/min

Table S5. The proportion of catalytic substance taken away by organic phase

Item	1-dodecene	C9~C13 olefines
Sample mass	20.92 g	22.56 g
Mass of wash water	101.45 g	98.68 g
The concentration of Al ³⁺ in wash water	42.823 mg/L	169.266 mg/L
Al taken away by organic phase	4.344 mg	16.703 mg
The initial mass of ionic liquid	1.0137 g	1.0217 g
Al contained in ionic liquid	151.101 mg	152.286 mg
The proportion of Al taken away by organic phase	2.875%	10.968%