Electronic Supplementary Material (ESI) for RSC Advances.

A. High frequency magnetic coil experimental device

Fig. S1

B. Numerical Data Underlying Key Figures

Figure S2 Deposition mass of undoped waxy oil under different magnetic treatments

Time (h)	Deposition mass (g)		
	Undoped waxy oil	With magnetic coil	With magnet
0.5	7.4	6.6	6.6
1	7.9	7.1	7.4
3	8.2	7.4	7.7
6	8.9	7.8	8.1
9	9.3	8.1	8.3

Figure S3 Wax deposition process after magnetic treatment with 0 and 24h of resting

a.Undoped waxy oil-with magnet

Time (h)	Deposition mass (g)		
	Undoped waxy oil	With magnet	After 24h (With magnet)
0.5	7.4	6.6	6.6
1	7.9	7.4	7.4
3	8.2	7.7	7.8
6	8.9	8.1	8.2
9	9.3	8.3	8.4

b. Doped waxy oil-with magnet

Time (h)	Deposition mass (g)		
	Doped waxy oil	With magnet	After 24h (With magnet)
0.5	5.8	4.3	4.5
1	6.6	5.1	5.2
3	7.2	5.9	6
6	7.7	6.2	6.3
9	8.2	6.5	6.5

c. Undoped waxy oil-with magnetic coil

Time (h)	Deposition mass (g)		
	Undoped waxy oil	With magnetic coil	After 24h (With magnetic coil)
0.5	7.4	6.6	6.6
1	7.9	7.1	7.2
3	8.2	7.4	7.5
6	8.9	7.8	7.9
9	9.3	8.1	8.3

d. Doped waxy oil-with magnetic coil

Time (h)	Deposition mass (g)		
	Doped waxy oil	With magnetic coil	After 24h (With magnetic coil)
0.5	5.8	5	5.1
1	6.6	6.1	6.2
3	7.2	6.7	6.8
6	7.7	7.3	7.4
9	8.2	7.9	7.9

Figure S4 Deposition mass of doped waxy oil under different magnetic treatments

Time (h)	Deposition mass (g)			
	Undoped waxy oil	Doped waxy oil (With magnet)	Doped waxy oil	Doped waxy oil (With magnetic coil)
0.5	7.4	4.3	5.8	5
1	7.9	5.1	6.6	6.1
3	8.2	5.9	7.2	6.7
6	8.9	6.2	7.7	7.3
9	9.3	6.5	8.2	7.9

Figure S5 Analysis on the synergistic effect efficiency of magnet and FNPPD

Time (h)	Inhibition efficiency (%)		
	FNPPD	Magnet	FNPPD+ magnet
0.5	21.62	10.81	41.89
1	16.46	6.33	35.44
3	12.20	6.10	28.05
6	13.48	8.99	30.34
9	11.83	10.75	30.11

Figure S6 Difference in the carbon number distribution with different magnetic treatments

a. Undoped waxy oil

Carbon number	△wt.%								
	Undoped waxy oil			With magnetic coil			With magnet		
	1h	3h	9h	1h	3h	9h	1h	3h	9h
C21	-0.010	-0.009	-0.007	-0.012	-0.009	-0.013	-0.010	-0.001	-0.008
C22	0.000	0.008	-0.006	-0.005	0.000	-0.011	0.000	-0.006	0.004
C23	-0.007	0.013	-0.016	-0.018	-0.010	-0.038	0.002	-0.010	-0.002
C24	-0.050	-0.009	-0.049	-0.044	-0.043	-0.079	0.005	-0.001	-0.039
C25	-0.016	0.038	0.015	-0.043	0.009	0.007	0.029	-0.011	0.018
C26	-0.020	0.038	0.074	-0.040	0.058	0.165	0.031	-0.004	0.057
C27	-0.008	0.058	0.197	-0.016	0.158	0.464	0.018	0.055	0.147
C28	0.019	0.084	0.316	0.022	0.263	0.740	0.038	0.071	0.253
C29	0.047	0.121	0.450	0.052	0.371	1.051	0.064	0.096	0.337
C30	0.058	0.125	0.510	0.059	0.396	1.147	0.081	0.081	0.404
C31	0.077	0.142	0.613	0.069	0.462	1.349	0.070	0.107	0.495
C32	0.098	0.155	0.665	0.078	0.491	1.423	0.065	0.119	0.556
C33	0.149	0.166	0.725	0.086	0.503	1.449	0.055	0.150	0.626
C34	0.088	0.168	0.618	0.097	0.458	1.341	0.067	0.095	0.535
C35	0.156	0.188	0.662	0.119	0.505	1.345	0.083	0.146	0.583
C36	0.090	0.125	0.519	0.069	0.386	1.111	0.063	0.080	0.464
C37	0.139	0.159	0.490	0.150	0.319	0.988	0.061	0.085	0.451
C38	0.142	0.163	0.386	0.106	0.391	0.753	0.080	0.069	0.368
C39	0.092	0.211	0.228	0.040	0.195	0.478	0.095	0.049	0.230
C40	0.134	0.040	0.187	0.115	0.167	0.354	0.020	0.021	0.194

b. Doped waxy oil

Carbon number	△wt.%								
	Doped waxy oil			With magnetic coil			With magnet		
	1h	3h	9h	1h	3h	9h	1h	3h	9h
C21	-0.005	-0.004	-0.011	-0.007	0.002	-0.012	0.005	0.003	-0.002
C22	-0.006	-0.006	-0.007	-0.004	-0.023	-0.008	-0.009	-0.023	-0.009
C23	-0.018	-0.020	-0.026	-0.013	-0.057	-0.030	-0.012	-0.042	-0.020
C24	-0.060	-0.048	-0.070	-0.070	-0.109	-0.062	-0.028	-0.080	-0.044
C25	-0.041	-0.028	-0.018	-0.077	-0.104	-0.045	-0.006	-0.054	0.005
C26	-0.028	0.004	0.051	-0.104	-0.060	0.003	0.002	-0.017	0.063
C27	0.006	0.099	0.206	0.035	0.122	0.169	0.036	0.048	0.170
C28	0.063	0.218	0.382	0.181	0.238	0.270	0.087	0.129	0.297
C29	0.128	0.381	0.612	0.339	0.364	0.458	0.126	0.197	0.450
C30	0.170	0.462	0.739	0.398	0.473	0.569	0.167	0.185	0.507
C31	0.235	0.577	0.956	0.496	0.646	0.724	0.192	0.228	0.607
C32	0.283	0.625	0.983	0.563	0.716	0.829	0.185	0.328	0.647

C33	0.317	0.654	0.988	0.624	0.819	0.896	0.170	0.307	0.652
C34	0.313	0.589	0.875	0.609	0.799	0.899	0.117	0.291	0.586
C35	0.342	0.619	0.885	0.619	0.798	0.925	0.166	0.344	0.613
C36	0.248	0.480	0.696	0.501	0.644	0.763	0.141	0.253	0.480
C37	0.263	0.455	0.630	0.470	0.599	0.713	0.101	0.266	0.450
C38	0.227	0.366	0.484	0.376	0.471	0.545	0.097	0.271	0.417
C39	0.125	0.296	0.308	0.233	0.288	0.393	0.024	0.194	0.231
C40	0.047	0.213	0.231	0.192	0.234	0.352	0.043	0.047	0.153

Figure S7 Carbon number distribution of the deposition layer with the magnet or magnetic coil

a.Undoped waxy oil-3h

Carbon number	Proportion wt.%		
	Undoped waxy oil (With magnetic coil)	Undoped waxy oil	Undoped waxy oil (With magnet)
C21	0.011	0.011	0.019
C22	0.067	0.075	0.061
C23	0.225	0.248	0.225
C24	0.427	0.461	0.469
C25	0.741	0.77	0.721
C26	0.831	0.811	0.769
C27	0.981	0.881	0.841
C28	0.995	0.816	0.77
C29	1.096	0.846	0.789
C30	1.055	0.784	0.74
C31	1.106	0.786	0.751
C32	1.086	0.75	0.714
C33	1.052	0.715	0.699
C34	0.959	0.669	0.596
C35	0.883	0.566	0.524
C36	0.751	0.49	0.428
C37	0.55	0.39	0.316
C38	0.509	0.323	0.187
C39	0.307	0.181	0.091
C40	0.187	0.06	0.069

b. Doped waxy oil-3h

Carbon number	Proportion wt.%		
	Doped waxy oil (With magnetic coil)	Doped waxy oil	Doped waxy oil (With magnet)
C21	0.022	0.016	0.023
C22	0.044	0.061	0.044

C23	0.178	0.215	0.193
C24	0.361	0.422	0.39
C25	0.628	0.704	0.678
C26	0.713	0.777	0.756
C27	0.858	0.922	0.871
C28	0.913	0.95	0.861
C29	1.089	1.106	0.922
C30	1.132	1.121	0.844
C31	1.29	1.221	0.836
C32	1.311	1.22	0.78
C33	1.445	1.203	0.719
C34	1.34	1.09	0.618
C35	1.303	0.997	0.544
C36	1.128	0.845	0.506
C37	0.944	0.686	0.332
C38	0.663	0.484	0.215
C39	0.505	0.325	0.136
C40	0.372	0.328	0.067

c. Undoped waxy oil-9h

Carbon number	Proportion wt.%		
	Undoped waxy oil (With magnetic coil)	Undoped waxy oil	Undoped waxy oil (With magnet)
C21	0.007	0.013	0.012
C22	0.056	0.061	0.071
C23	0.197	0.219	0.233
C24	0.391	0.421	0.431
C25	0.739	0.747	0.75
C26	0.938	0.847	0.83
C27	1.287	1.02	0.97
C28	1.472	1.048	0.985
C29	1.776	1.175	1.062
C30	1.806	1.169	1.063
C31	1.993	1.257	1.139
C32	2.018	1.26	1.151
C33	1.998	1.274	1.175
C34	1.842	1.119	1.036
C35	1.723	1.04	0.961
C36	1.476	0.884	0.829
C37	1.219	0.721	0.682
C38	0.871	0.504	0.486
C39	0.507	0.257	0.259
C40	0.469	0.302	0.309

d. Doped waxy oil-9h

Carbon number	Proportion wt.%		
	Doped waxy oil (With magnetic coil)	Doped waxy oil	Doped waxy oil (With magnet)
C21	0.008	0.009	0.018
C22	0.059	0.06	0.058
C23	0.205	0.209	0.215
C24	0.408	0.4	0.426
C25	0.787	0.714	0.737
C26	0.976	0.824	0.836
C27	1.392	1.029	0.993
C28	1.562	1.114	1.029
C29	1.883	1.337	1.175
C30	1.928	1.398	1.166
C31	2.238	1.6	1.251
C32	2.384	1.578	1.242
C33	2.475	1.537	1.201
C34	2.4	1.376	1.087
C35	2.103	1.263	0.991
C36	1.728	1.061	0.845
C37	1.344	0.861	0.681
C38	0.963	0.602	0.535
C39	0.722	0.337	0.26
C40	0.467	0.346	0.268

Figure S8 Wax content in the deposition layer with the magnet or magnetic coil

a. With the magnet

Time (h)	Wax content(wt.%)			
	Undoped waxy oil	Undoped waxy oil (With magnet)	Doped waxy oil	Doped waxy oil (With magnet)
0.5	10.11	9.57	12.15	11.92
1	12.15	10.49	15.14	12.73
3	12.96	10.83	15.98	13.81
9	15.56	13.34	19.34	16.92

b.With the magnetic coil

Time (h)	Wax content(wt.%)			
	Undoped waxy oil	Undoped waxy oil (With magnetic coil)	Doped waxy oil	Doped waxy oil (With magnetic coil)
0.5	10.11	13.33	12.15	13.37
1	12.15	14.85	15.14	17.26

3	12.96	16.07	15.98	19.12
9	15.56	19.44	19.34	21.84

Figure S9 Wax content of doped waxy oil in the deposition layer under different magnetic treatments

Time (h)	Wax content(wt.%)			
	Undoped waxy oil	Doped waxy oil	Doped waxy oil (With magnet)	Doped waxy oil (With magnetic coil)
0.5	10.11	12.15	11.92	13.37
1	12.15	15.14	12.73	17.26
3	12.96	15.98	13.81	19.12
9	15.56	19.34	16.92	21.84

Figure S10 Wax precipitation properties of waxy oil under magnet treatment.

a. Wax appearance temperature

Temperature (°C)	Heat flow (W/g)			
	Undoped waxy oil	Doped waxy oil	Undoped waxy oil (With magnet)	Doped waxy oil (With magnet)
-20	0.3205	0.1798	0.2892	0.2473
-19	0.3211	0.1804	0.2901	0.248
-18	0.3219	0.1813	0.2911	0.2487
-17	0.3227	0.1821	0.2922	0.2495
-16	0.3236	0.183	0.2934	0.2504
-15	0.3244	0.184	0.2948	0.2514
-14	0.3252	0.185	0.2964	0.2525
-13	0.326	0.1859	0.2979	0.2536
-12	0.3267	0.187	0.2994	0.2548
-11	0.3274	0.1881	0.3009	0.2559
-10	0.3283	0.1891	0.3025	0.2569
-9	0.3293	0.1901	0.304	0.2578
-8	0.3305	0.191	0.3057	0.259
-7	0.3315	0.1921	0.3074	0.2603
-6	0.3325	0.1933	0.3091	0.2617
-5	0.3337	0.1945	0.3108	0.263
-4	0.3347	0.1957	0.3125	0.2642
-3	0.3357	0.1968	0.3141	0.2654
-2	0.3368	0.1981	0.3161	0.2669
-1	0.3381	0.1997	0.3183	0.2686
0	0.3395	0.2014	0.3206	0.2704
1	0.3409	0.203	0.3229	0.2723
2	0.3426	0.2048	0.3254	0.2742
3	0.3446	0.2069	0.3281	0.276

4	0.3466	0.2091	0.3309	0.2781
5	0.3484	0.2111	0.3335	0.28
6	0.3504	0.2128	0.3361	0.2822
7	0.3524	0.2144	0.3389	0.2844
8	0.3544	0.2161	0.3417	0.2867
9	0.3564	0.2178	0.3445	0.2891
10	0.3584	0.2198	0.3471	0.2914
11	0.3601	0.2221	0.3494	0.2932
12	0.3618	0.2245	0.3516	0.2952
13	0.3634	0.2262	0.3536	0.297
14	0.3647	0.2276	0.3553	0.2985
15	0.3659	0.2286	0.3566	0.2993
16	0.3667	0.2292	0.3575	0.3003
17	0.3673	0.2295	0.3584	0.3011
18	0.3676	0.2299	0.3594	0.3017
19	0.3675	0.2301	0.3611	0.3023
20	0.3671	0.2304	0.3642	0.3028
21	0.3666	0.2311	0.3693	0.3047
22	0.3666	0.2327	0.3727	0.3079
23	0.3675	0.2386	0.3543	0.3152
24	0.3699	0.2432	0.3055	0.3444
25	0.3719	0.2424	0.2957	0.2997
26	0.3706	0.2222	0.2949	0.2577
27	0.3504	0.2145	0.2948	0.254
28	0.3187	0.19	0.2947	0.2534
29	0.3159	0.1849	0.2944	0.2533
30	0.3152	0.1842	0.2943	0.2529
31	0.3144	0.1834	0.2941	0.2528
32	0.3135	0.1826	0.2937	0.2527
33	0.3125	0.1816	0.2929	0.2524
34	0.3115	0.1805	0.2919	0.2522
35	0.3103	0.1794	0.2908	0.2519
36	0.3087	0.1782	0.2897	0.2517
37	0.3067	0.1769	0.2886	0.2515
38	0.3046	0.1755	0.2876	0.2511
39	0.3024	0.174	0.2865	0.2507
40	0.3	0.1724	0.2855	0.2499
41	0.2973	0.1707	0.2842	0.2486
42	0.2946	0.1687	0.2827	0.2471
43	0.2917	0.1666	0.2811	0.245
44	0.2887	0.1644	0.2794	0.2431
45	0.2854	0.1618	0.2773	0.2411
46	0.2819	0.1586	0.275	0.2388

47	0.2781	0.155	0.2723	0.2365
48	0.274	0.1511	0.2694	0.2339
49	0.2695	0.1471	0.2662	0.2312
50	0.2644	0.1432	0.2629	0.2283
51	0.2586	0.139	0.2592	0.225
52	0.2522	0.1344	0.2554	0.2212
53	0.2451	0.1292	0.2511	0.2171
54	0.2374	0.1233	0.2463	0.2125
55	0.2294	0.1171	0.2412	0.2073
56	0.2194	0.1071	0.2356	0.2018
57	0.2034	0.08543	0.2258	0.1924
58	0.1662	0.03409	0.2013	0.1676
59	0.04526	-0.1014	0.1144	0.08036

b. Wax precipitation amount

Temperature (°C)	Cumulative wax precipitation (wt.%)			
	Undoped waxy oil	Doped waxy oil	Undoped waxy oil (With magnet)	Doped waxy oil (With magnet)
-20	10.08371	7.78098	9.51476	7.62079
-19	10.05195	7.81619	9.55964	7.66705
-18	10.01605	7.84726	9.59831	7.70848
-17	9.97462	7.87212	9.63007	7.74507
-16	9.92767	7.89145	9.65424	7.77614
-15	9.8745	7.90457	9.67012	7.801
-14	9.81581	7.91079	9.67633	7.81895
-13	9.7516	7.9101	9.6715	7.82931
-12	9.68186	7.90319	9.65631	7.83207
-11	9.60729	7.88869	9.63076	7.82655
-10	9.52788	7.8666	9.59486	7.81343
-9	9.44226	7.8376	9.5479	7.7934
-8	9.34974	7.80169	9.4906	7.76717
-7	9.24893	7.75957	9.42155	7.73264
-6	9.14121	7.70986	9.34076	7.68914
-5	9.0266	7.65186	9.24824	7.63598
-4	8.90369	7.58557	9.14398	7.57383
-3	8.77388	7.511	9.02798	7.5034
-2	8.63717	7.42883	8.90093	7.42469
-1	8.49286	7.33769	8.76007	7.33562
0	8.33957	7.2355	8.60402	7.23481
1	8.17662	7.12157	8.4321	7.12157
2	8.004	6.9966	8.24429	6.99521
3	7.81964	6.85919	8.03921	6.85574

4	7.62148	6.70729	7.8155	6.70383
5	7.4095	6.54019	7.57245	6.53743
6	7.1851	6.35929	7.31145	6.3579
7	6.94688	6.16664	7.0325	6.16319
8	6.69486	5.96295	6.73421	5.95329
9	6.42902	5.74752	6.4166	5.7275
10	6.14938	5.52036	6.07964	5.48514
11	5.85593	5.27938	5.72474	5.2269
12	5.55074	5.02252	5.35395	4.95624
13	5.23381	4.7491	4.96798	4.67176
14	4.90583	4.46393	4.56819	4.37486
15	4.56888	4.1691	4.15667	4.0676
16	4.22364	3.86736	3.73617	3.75481
17	3.87288	3.56148	3.30945	3.43512
18	3.51798	3.25352	2.87652	3.1099
19	3.161	2.94281	2.43669	2.78055
20	2.80471	2.63071	1.98512	2.44705
21	2.45119	2.31655	1.51214	2.1101
22	2.10112	1.99755	1.00395	1.76002
23	1.75105	1.6675	0.47229	1.38786
24	1.39476	1.29671	0.06767	0.96529
25	1.0219	0.89417	0	0.3411
26	0.63524	0.49714	0	0.02555
27	0.25755	0.2396	0	0
28	0.01933	0.03521	0	0

Figure S11 Avrami fitting diagram for waxy oil under magnet treatment

log(t)	Log(-ln(1-X(t)))			
	Undoped waxy oil (With magnet)	Doped waxy oil (With magnet)	Undoped waxy oil	Doped waxy oil
0.78	0.55329	0.62047	0.26638	0.45716
0.76	0.51121	0.56349	0.24419	0.42452
0.75	0.47316	0.51661	0.22150	0.39236
0.73	0.43789	0.47463	0.19830	0.36070
0.72	0.40386	0.43546	0.17428	0.32902
0.70	0.37039	0.39793	0.14917	0.29679
0.68	0.33714	0.36148	0.12296	0.26386
0.66	0.30394	0.32584	0.09576	0.23041
0.64	0.27040	0.29022	0.06733	0.19666
0.62	0.23620	0.25467	0.03760	0.16254
0.60	0.20111	0.21856	0.00643	0.12774
0.58	0.16521	0.18172	-0.02633	0.09203

0.56	0.12829	0.14382	-0.06086	0.05490
0.53	0.08997	0.10453	-0.09716	0.01578
0.51	0.05001	0.06369	-0.13551	-0.02572
0.48	0.00809	0.02154	-0.17618	-0.06925
0.45	-0.03599	-0.02255	-0.21934	-0.11495
0.41	-0.08242	-0.06881	-0.26539	-0.16290
0.38	-0.13169	-0.11746	-0.31459	-0.21327
0.34	-0.18432	-0.16834	-0.36749	-0.26638
0.30	-0.24091	-0.22242	-0.42468	-0.32317
0.26	-0.30217	-0.28035	-0.48688	-0.38443
0.20	-0.36913	-0.34302	-0.55517	-0.45171
0.15	-0.44370	-0.41197	-0.63142	-0.52770
0.08	-0.52894	-0.48920	-0.71956	-0.61765
0.00	-0.63079	-0.58071	-0.82719	-0.73920
-0.10	-0.76176	-0.69673	-0.97121	-0.91338
-0.22	-0.95270	-0.86827	-1.18663	-1.18029
-0.40	-1.29318	-1.33922	-1.58716	-1.50478
-0.70	-2.14647	-2.47392	-2.71690	-2.34333

Figure S12 Crystal size distribution and SIG model fitting diagram

a. Size distribution of wax crystals in undoped waxy oil - before and after magnetic treatment

Chord length μm	Proportion%	
	Undoped waxy oil	Undoped waxy oil (With magnet)
1~2	4.38	5.60
2~4	12.53	14.52
4~8	24.56	27.47
8~16	31.01	30.98
16~32	17.41	18.61
32~64	7.68	2.83
>64	2.44	0.00

b. Size distribution of wax crystals in doped waxy oil - before and after magnetic treatment

Chord length μm	Proportion%	
	Doped waxy oil	Doped waxy oil (With magnet)
1~2	5.44	8.30
2~4	15.93	18.99
4~8	26.40	27.67
8~16	26.31	25.71
16~32	15.48	13.58
32~64	7.46	4.73
>64	2.97	1.03