



Supplement of

In situ real-time determination of SO₂ photochemical oxidation in nanoscale sea salt aerosols based on dark-field microscopy

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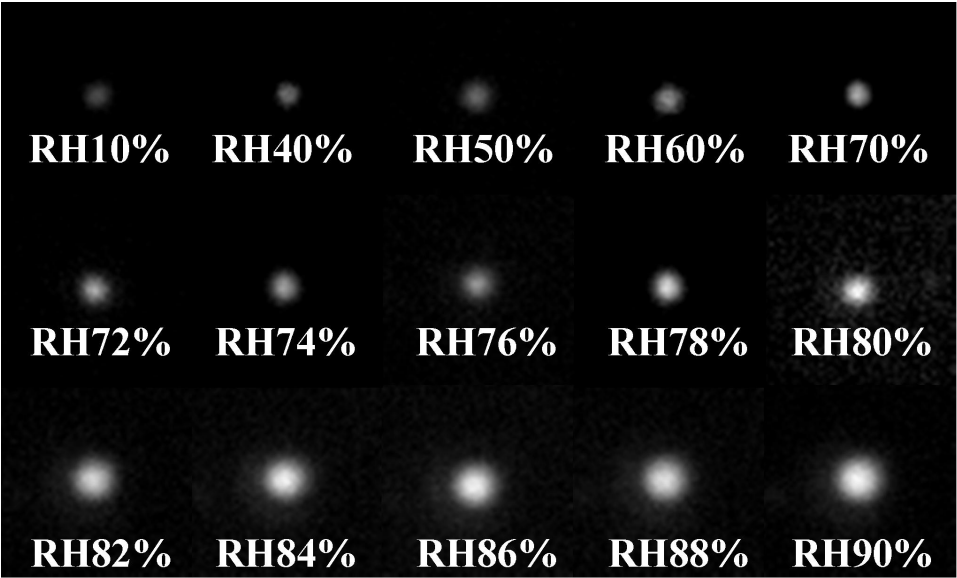


Figure S1. In situ dark-field images of NaCl single nano-particle(100nm) with the reaction time of 1h at humidification process.

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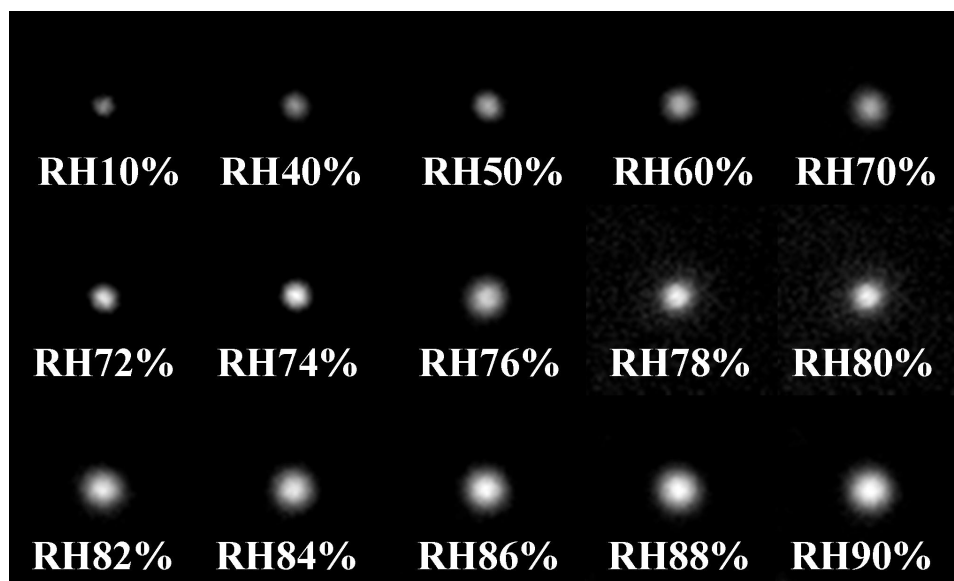
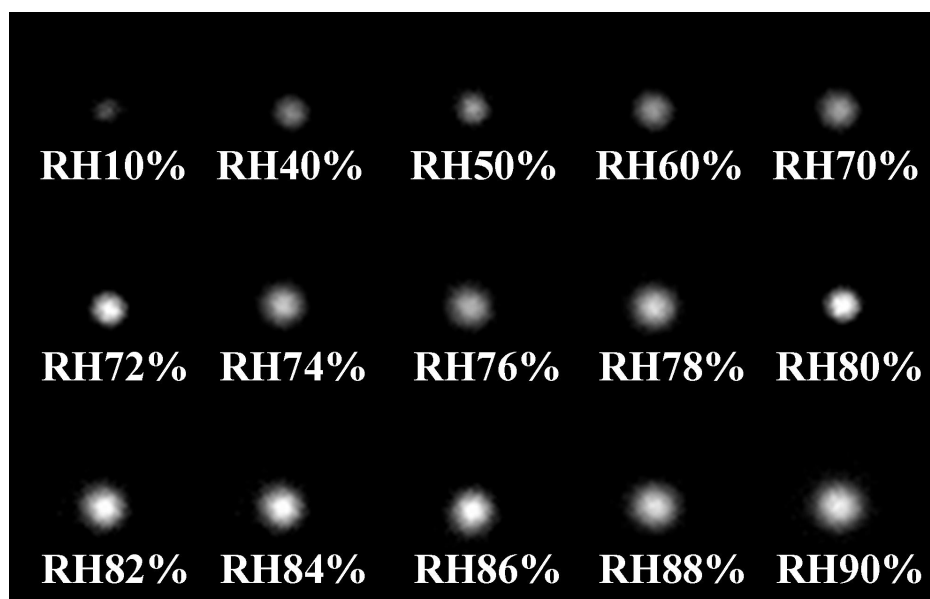


Figure S2. In situ dark-field images of NaCl single nano-particle(100nm) with the reaction time of 2h at humidification process.



55 **Figure S3.** In situ dark-field images of NaCl single nano-particle(100nm) with the reaction time of 3h at humidification process.

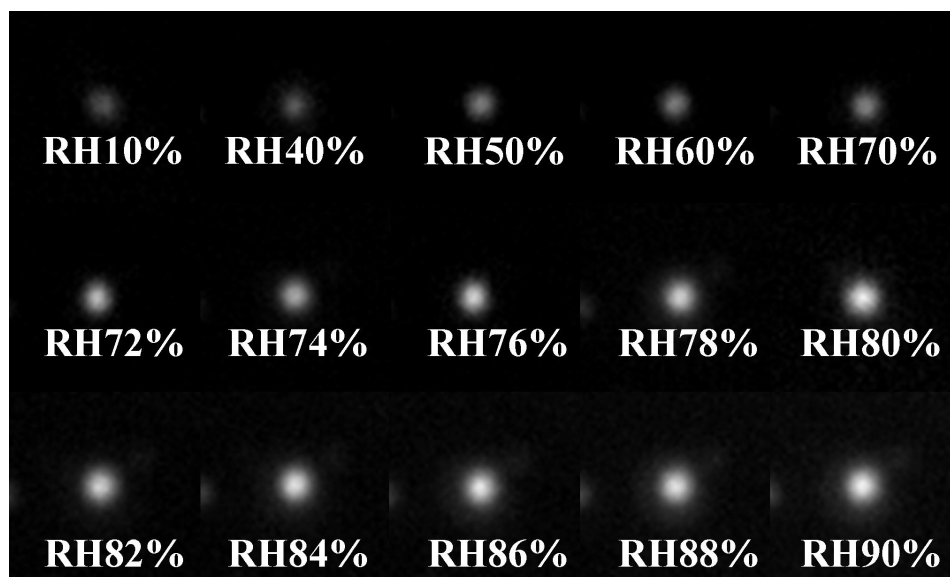


Figure S4. In situ dark-field images of NaCl single nano-particle(100nm) with the reaction time of 4h at humidification process.

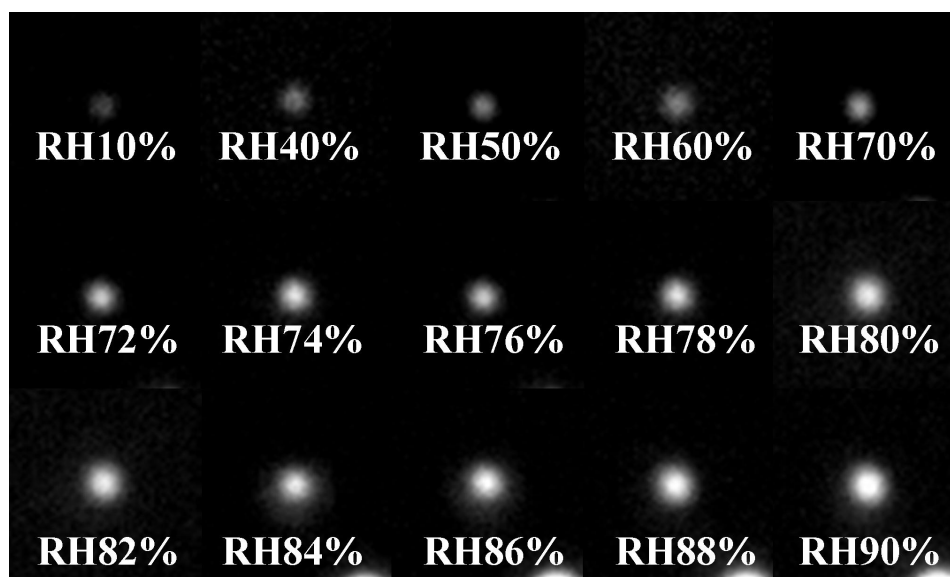


Figure S5. In situ dark-field images of NaCl single nano-particle(100nm) with the reaction time of 5h at humidification process.

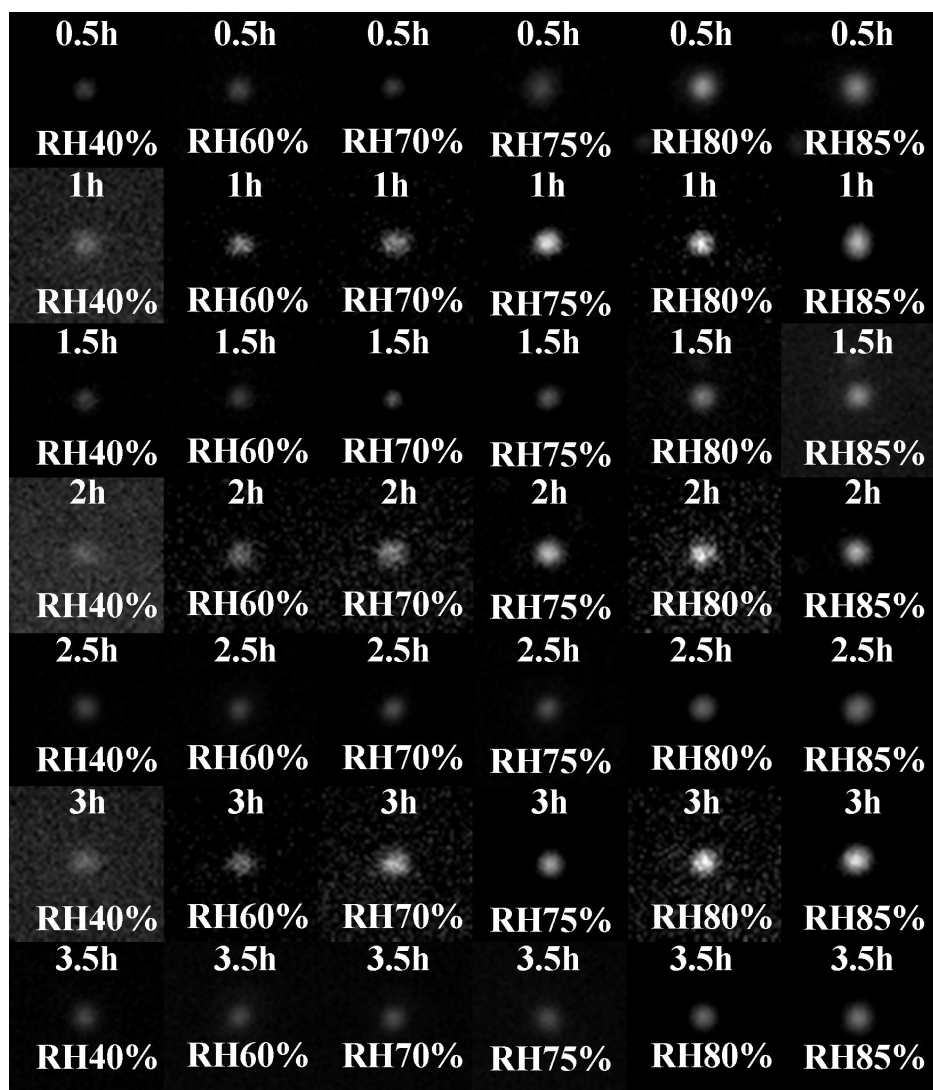
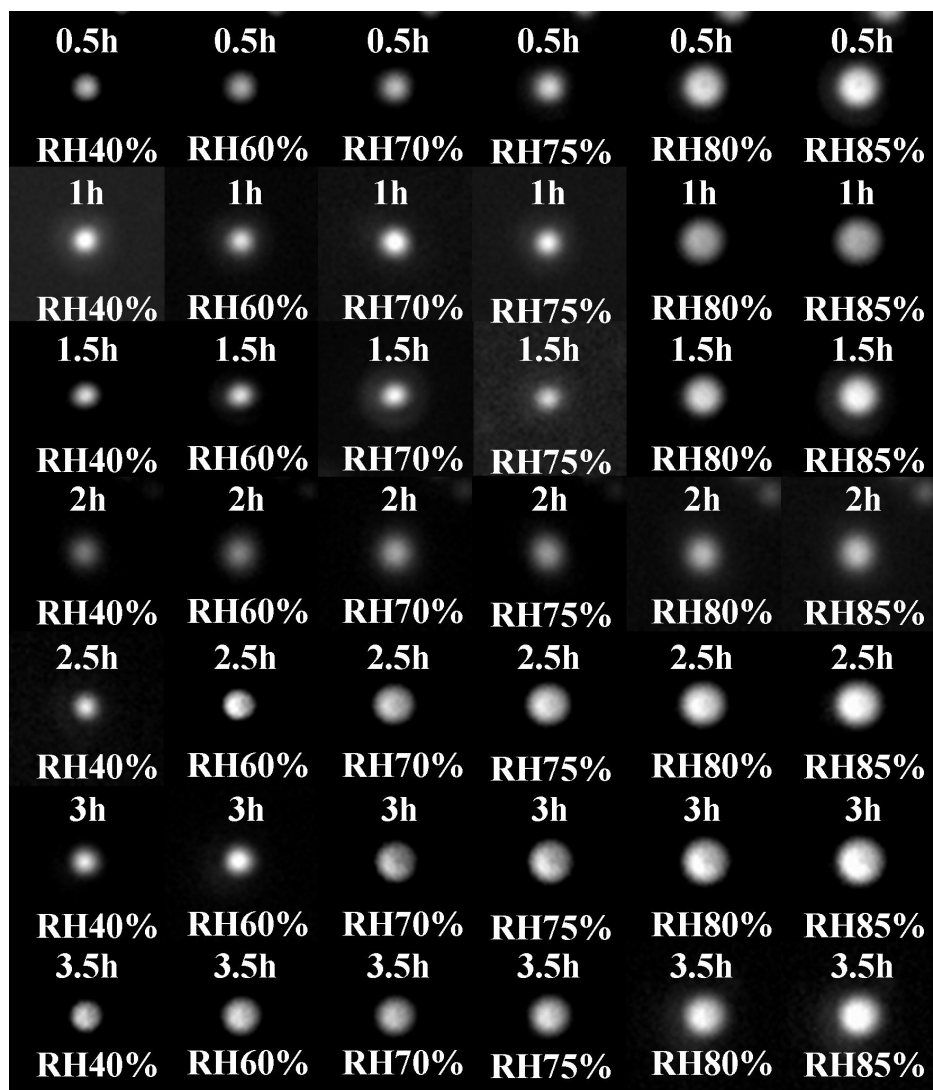


Figure S6. In situ dark-field images of NaCl single nano-particle (50 nm) with the reaction time of from 0.5 h to 3.5 h at humidification process.



Figure S7. In situ dark-field images of NaCl single nano-particle (150 nm) with the reaction time of from 0.5 h to 3.5 h at humidification process.



70 **Figure S8.** In situ dark-field images of NaCl single nano-particle (200 nm) with the reaction time of from 0.5 h to 3.5 h at humidification process.

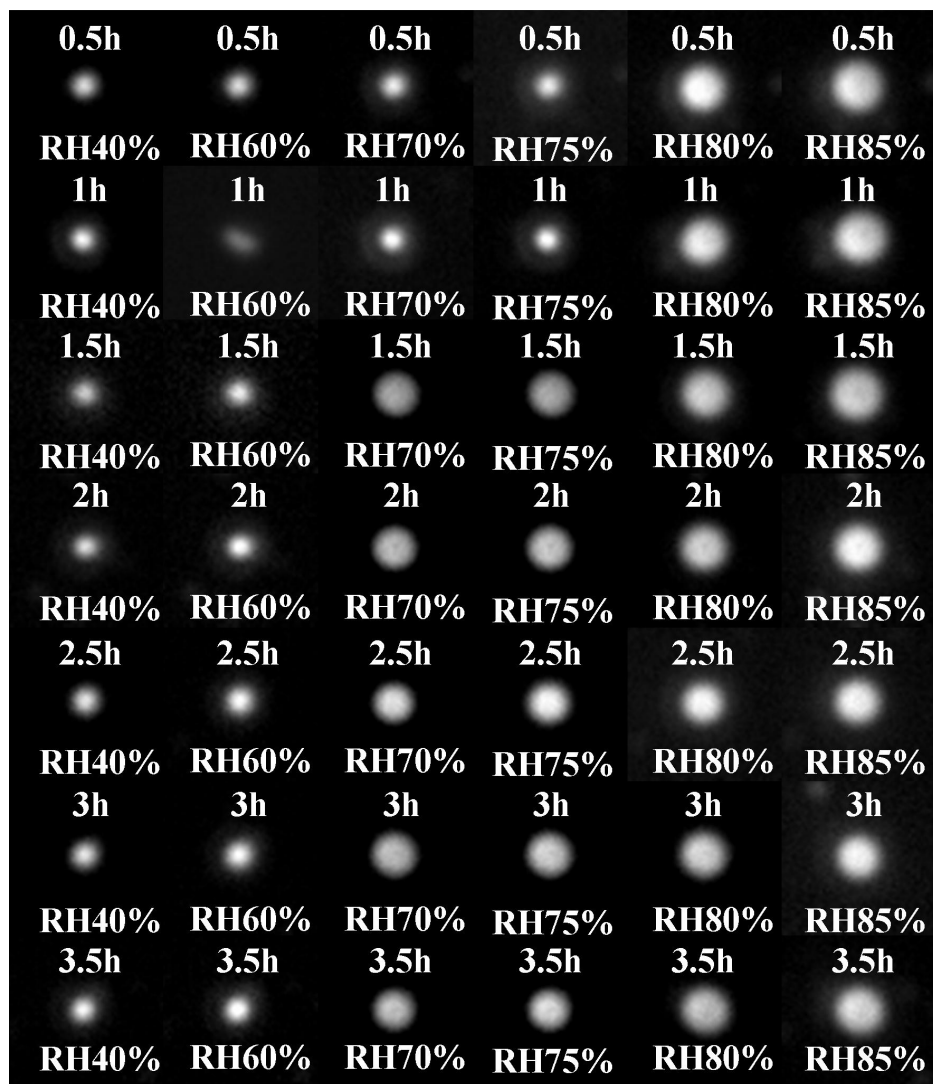
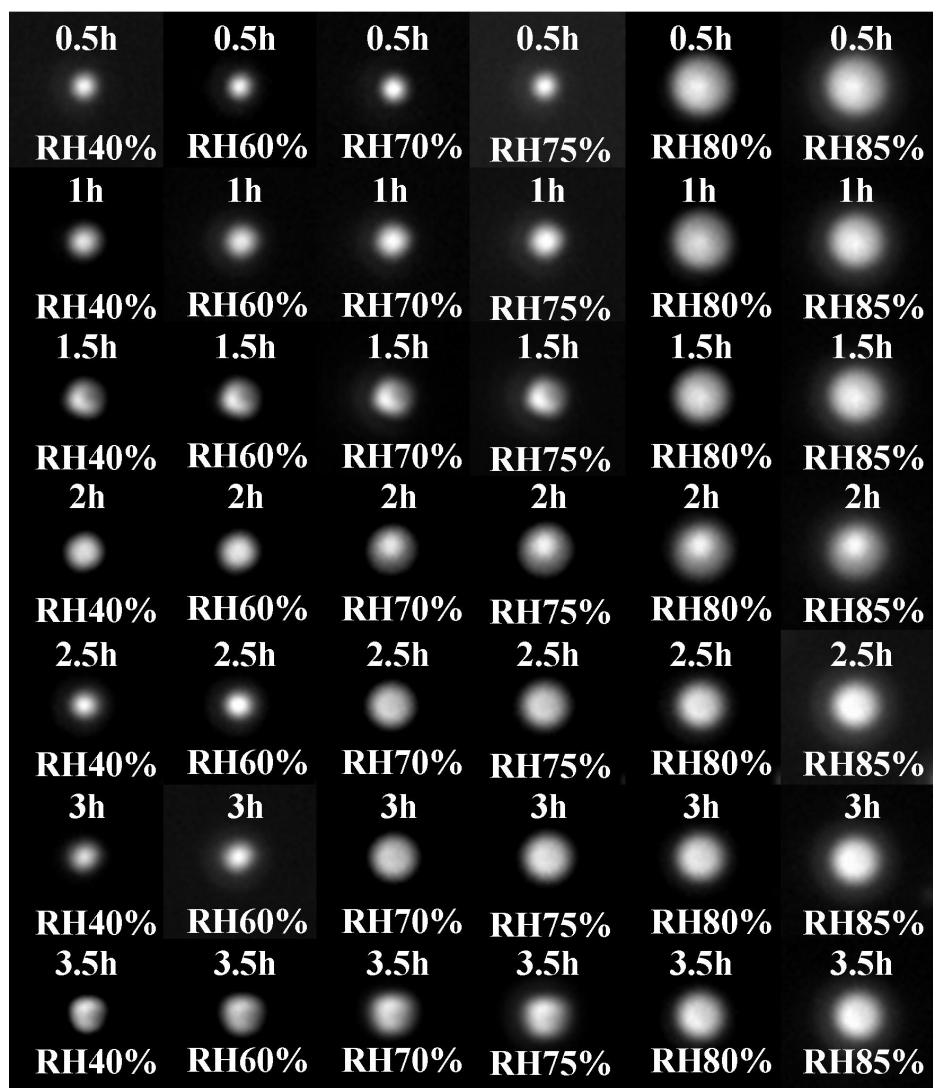


Figure S9. In situ dark-field images of NaCl single nano-particle (250 nm) with the reaction time of from 0.5 h to 3.5 h at humidification process.



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Figure S10. In situ dark-field images of NaCl single nano-particle (300 nm) with the reaction time of from 0.5 h to 3.5 h at humidification process.

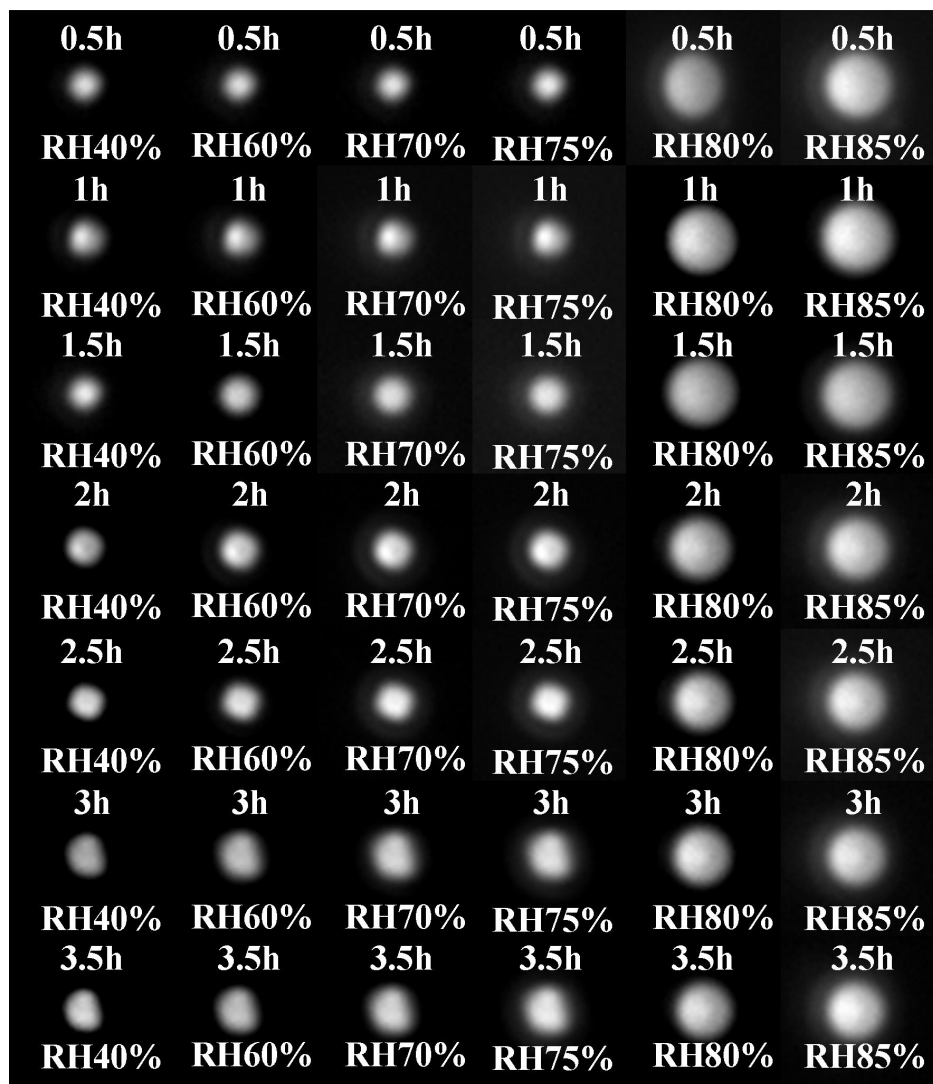


Figure S11. In situ dark-field images of NaCl single nano-particle (350 nm) with the reaction time of from 0.5 h to 3.5 h at humidification process.

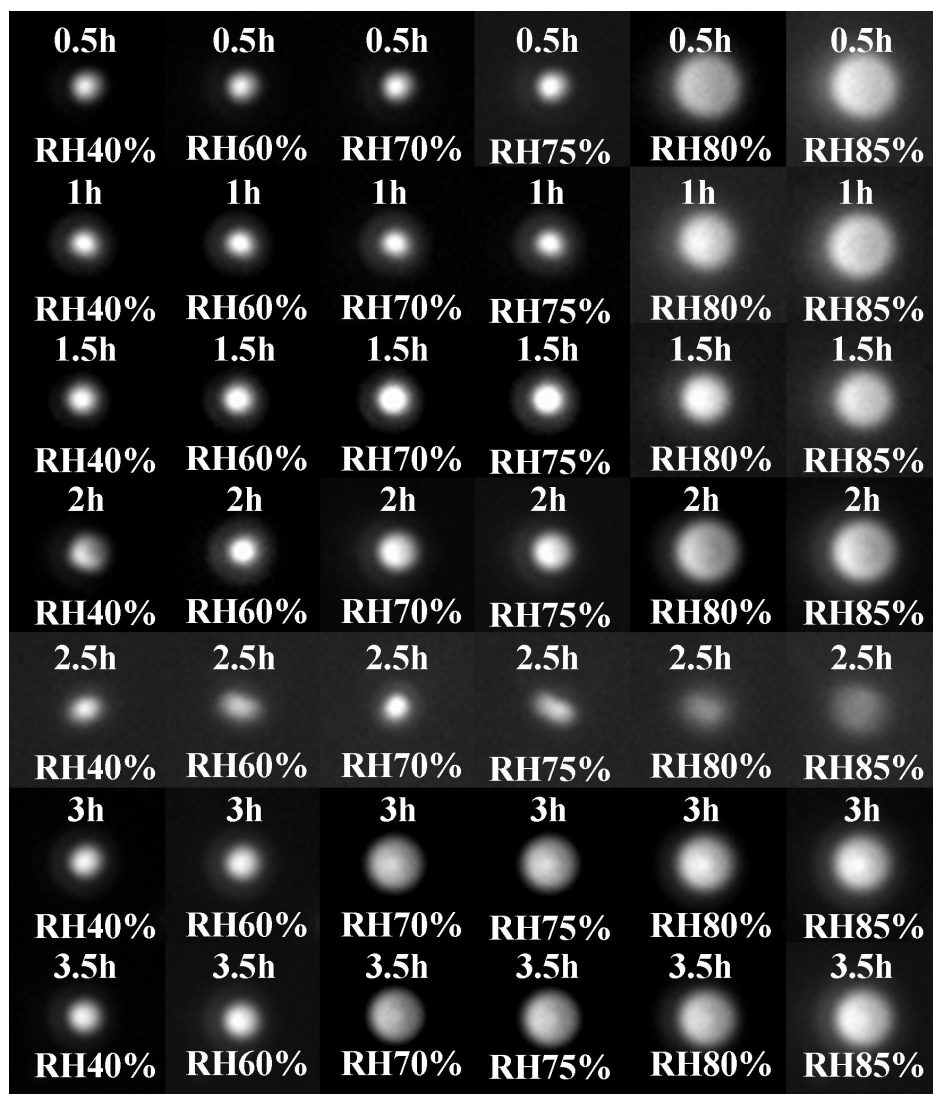
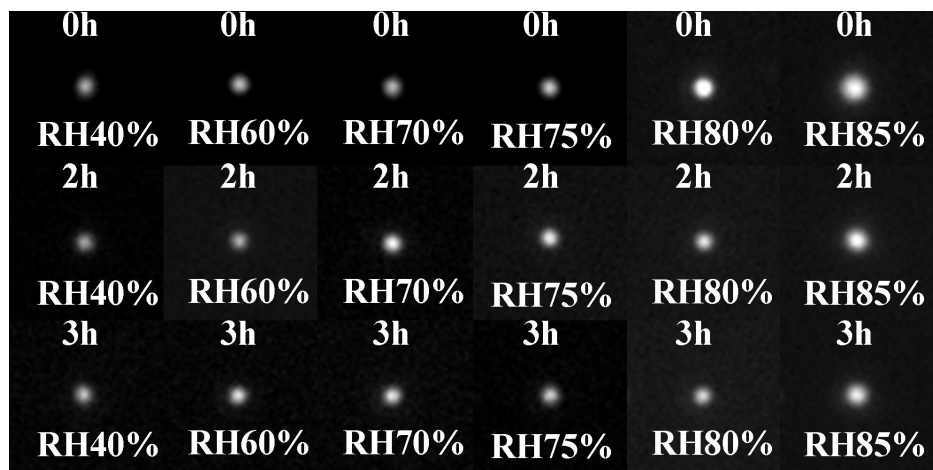


Figure S12. In situ dark-field images of NaCl single nano-particle (400 nm) with the reaction time of from 0.5 h to 3.5 h at humidification process.



85 **Figure S13.** In situ dark-field images of NaCl-SOS mixed nano-particle with 5% OVf and aged for 0 h, 2 h and 3 h at humidification process.

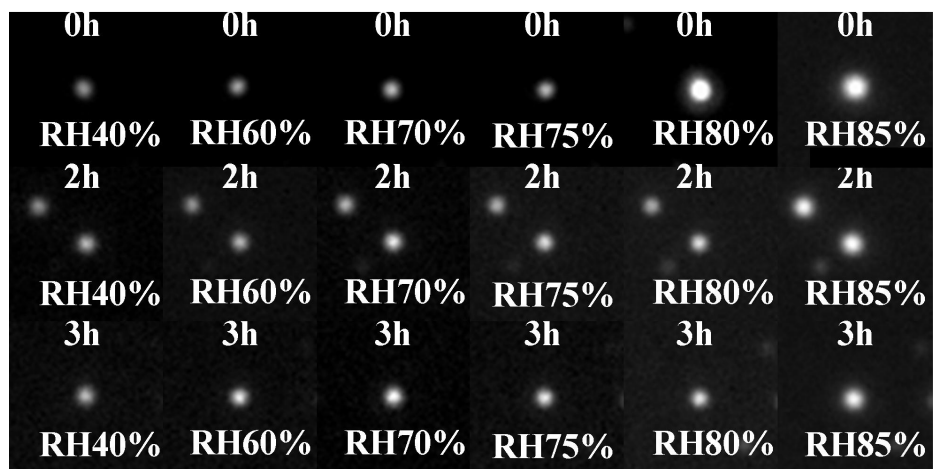


Figure S14. In situ dark-field images of NaCl-SOS mixed nano-particle with 10%OVf and aged for 0 h, 2 h and 3 h at humidification process.

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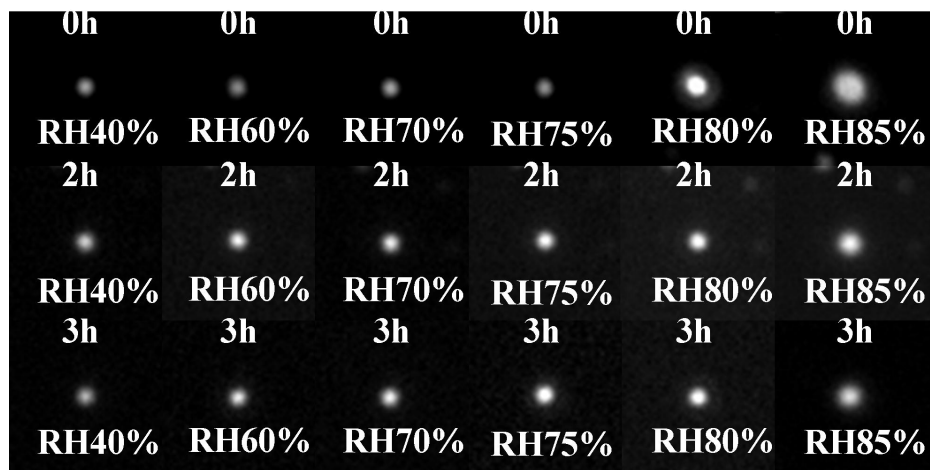


Figure S15. In situ dark-field images of NaCl-SOS mixed nano-particle with 18%OVF and aged for 0 h, 2 h and 3 h at humidification process.

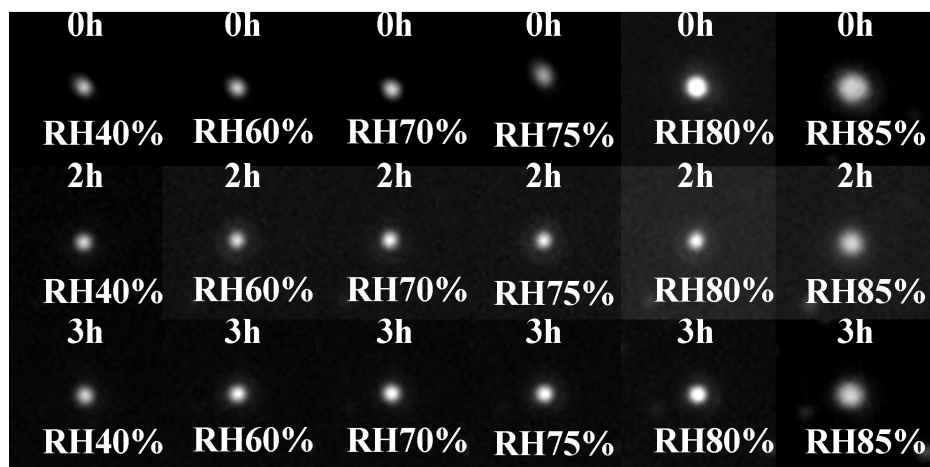


Figure S16. In situ dark-field images of NaCl-SOS mixed nano-particle with 33% OVF and aged for 0 h, 2 h and 3 h at humidification process.

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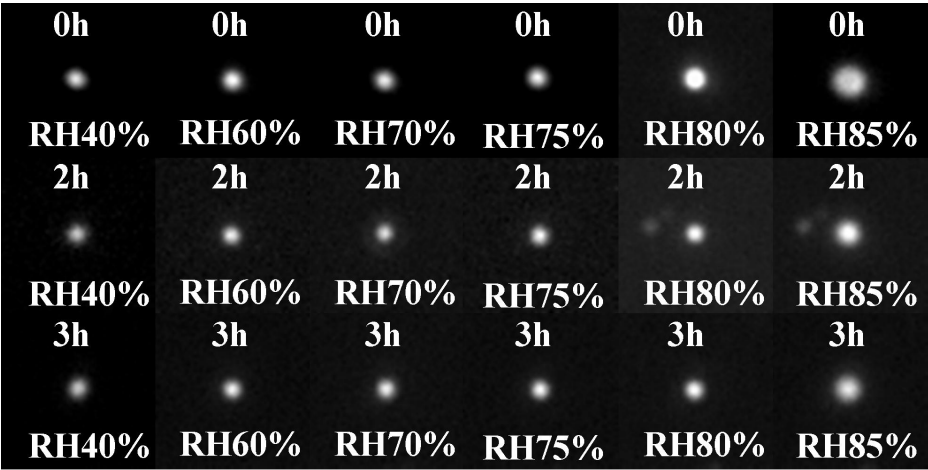


Figure S17. In situ dark-field images of NaCl-SOS mixed nano-particle with 50% OVF and aged for 0 h, 2 h and 3 h at humidification process.

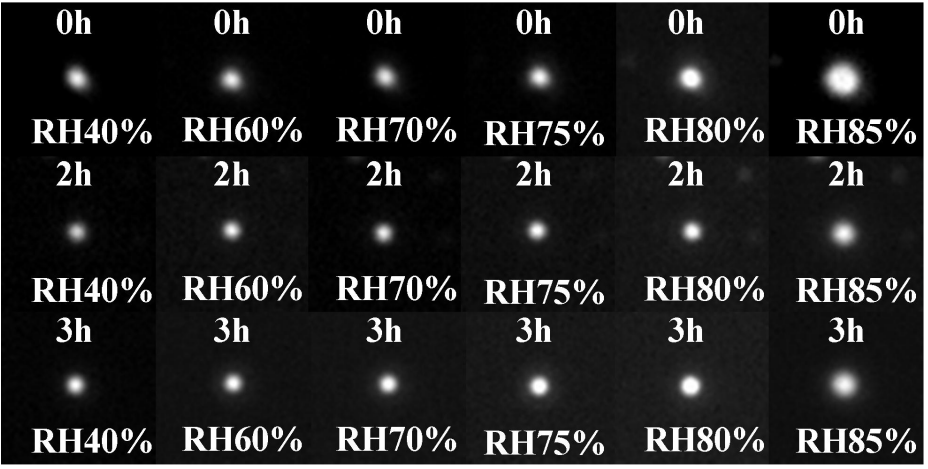


Figure S18. In situ dark-field images of NaCl-SOS mixed nano-particle with 70% OVF and aged for 0 h, 2 h and 3 h at humidification process.

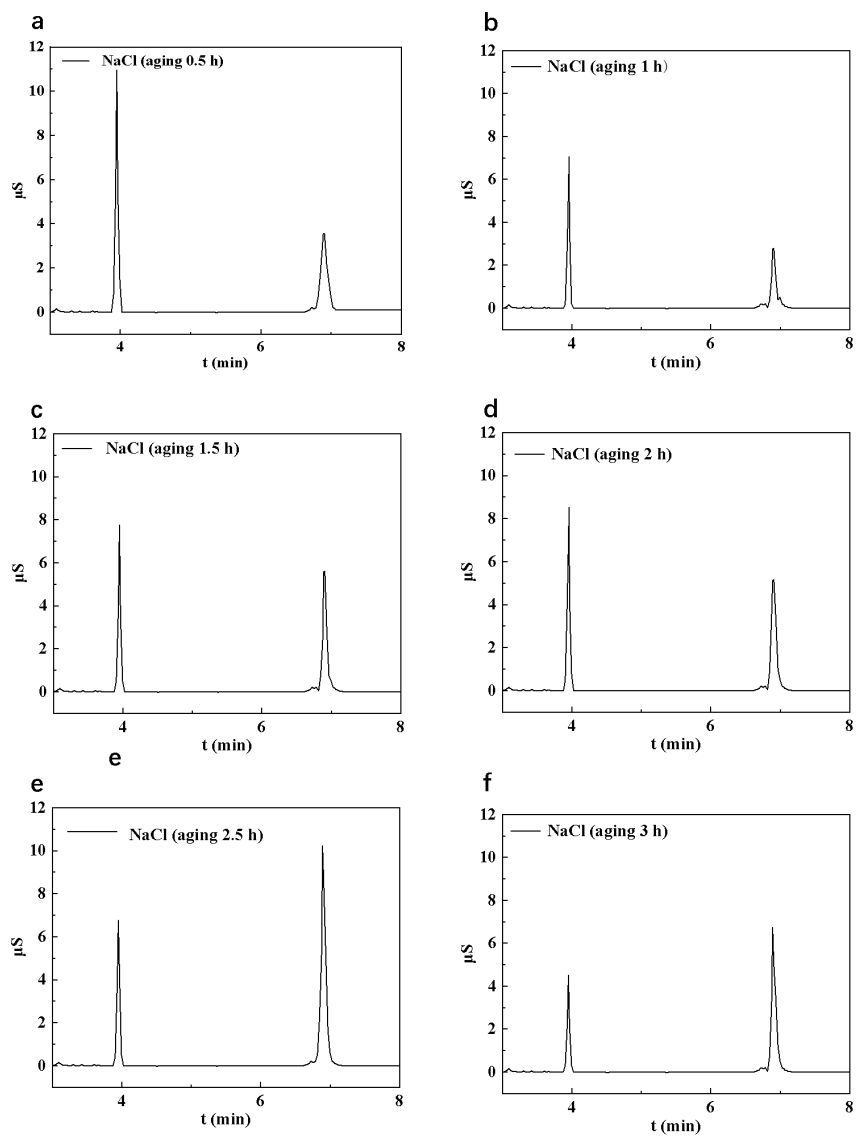
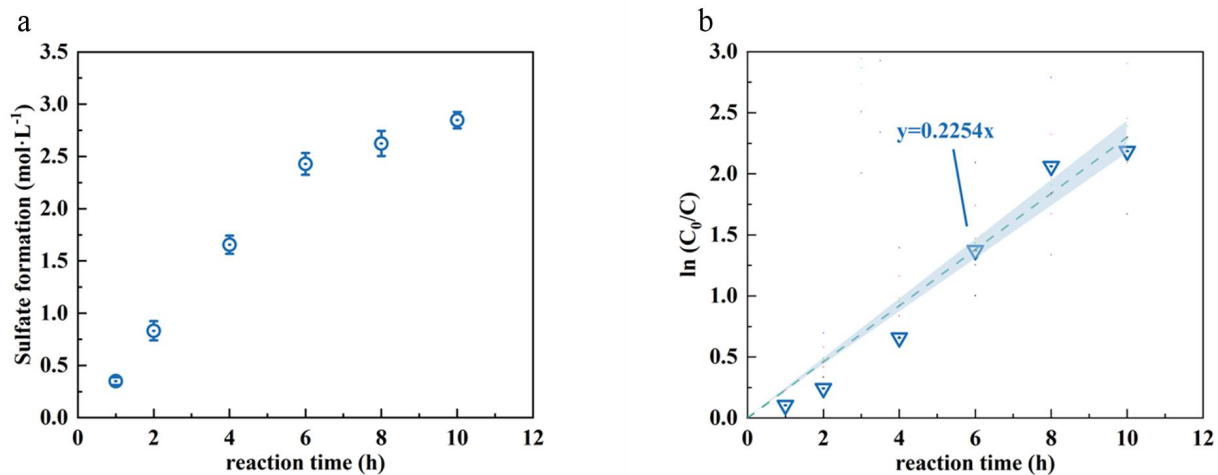


Figure S19. ion chromatography analysis of NaCl single nanoparticles (100 nm) aged for 0.5 h, 1 h, 1.5 h, 2 h, 2.5 h, 3 h.



105 **Figure S20.** (a) Sulfate concentration and (b) $\ln(C_0/C)$ of 100 nm NaCl droplets formed at 80 % RH at 20ppm SO₂ as a function of reaction time.

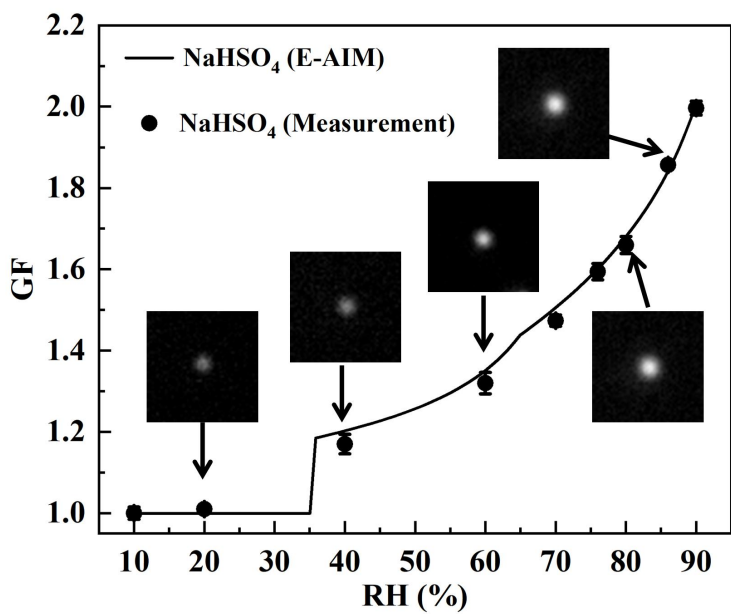


Figure S21.Hygroscopic growth behavior of a single 100 nm NaCl particle

Table S1. The measured values of the growth factors for NaCl single nano-particles at different relative humidities after aging.

D(nm)	RH(%)	GF(0.5h)	GF(1h)	GF(1.5h)	GF(2h)	GF(2.5h)	GF(3h)	GF(3.5h)
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50	40	1.05±0.01	1.08±0.01	1.10±0.02	1.13±0.02	1.16±0.02	1.18±0.02	1.18±0.02
	60	1.10±0.02	1.16±0.01	1.17±0.02	1.23 ±0.01	1.28±0.02	1.31±0.01	1.32±0.02
	70	1.13±0.03	1.20±0.01	1.23 ±0.04	1.33±0.01	1.40±0.01	1.44±0.02	1.47±0.02
	75	1.16±0.03	1.25±0.01	1.27±0.02	1.38±0.03	1.47±0.02	1.50±0.02	1.52±0.02
	80	1.92±0.01	1.87±0.03	1.84±0.02	1.79±0.02	1.73±0.02	1.71 ±0.01	1.70 ±0.01
	85	2.06±0.01	2.01±0.03	2.00±0.02	1.92±0.03	1.88 ±0.04	1.84±0.03	1.83±0.03
150	40	1.13±0.01	1.13±0.01	1.16 ±0.01	1.18±0.01	1.19±0.01	1.19±0.01	1.19±0.01
	60	1.22±0.02	1.23±0.01	1.27±0.01	1.31±0.02	1.34±0.01	1.34±0.01	1.34±0.01
	70	1.31±0.02	1.33±0.02	1.39±0.02	1.46±0.02	1.48±0.02	1.49±0.02	1.50±0.02
	75	1.37±0.02	1.38±0.02	1.46±0.02	1.52±0.02	1.55±0.03	1.56±0.02	1.53±0.03
	80	1.80±0.02	1.77±0.02	1.74±0.03	1.71±0.03	1.69±0.02	1.68±0.02	1.67±0.02
	85	1.94±0.03	1.95±0.05	1.88±0.03	1.85±0.02	1.82±0.05	1.83±0.02	1.81±0.02
200	40	1.13±0.01	1.16±0.02	1.18±0.02	1.19±0.02	1.20±0.00	1.20±0.02	1.20±0.02
	60	1.24±0.01	1.28±0.02	1.31±0.02	1.34±0.02	1.34±0.01	1.34±0.02	1.35±0.02
	70	1.33±0.02	1.41±0.02	1.45±0.04	1.49±0.01	1.50±0.02	1.50±0.02	1.50±0.02
	75	1.39±0.02	1.48±0.02	1.50±0.02	1.56±0.02	1.57±0.02	1.56±0.02	1.57±0.02
	80	1.78±0.02	1.73±0.03	1.71±0.03	1.68±0.03	1.68±0.03	1.67±0.02	1.68±0.02
	85	1.91±0.04	1.87±0.02	1.83±0.03	1.81±0.03	1.81±0.02	1.80±0.02	1.81±0.02
250	40	1.12±0.01	1.14±0.02	1.17±0.03	1.18±0.02	1.20±0.02	1.20±0.01	1.20±0.01
	60	1.21±0.01	1.25±0.02	1.30±0.01	1.33±0.01	1.34±0.02	1.35±0.02	1.35±0.02
	70	1.31±0.02	1.35±0.02	1.44±0.01	1.46±0.01	1.49±0.01	1.50±0.02	1.51±0.02
	75	1.35±0.02	1.41±0.01	1.49±0.02	1.53±0.02	1.55±0.02	1.56±0.01	1.57±0.02
	80	1.81±0.02	1.78±0.02	1.72±0.03	1.70±0.02	1.68±0.02	1.67±0.03	1.68±0.02
	85	1.96±0.02	1.91±0.03	1.84±0.06	1.83±0.02	1.81±0.03	1.81±0.02	1.79±0.06
300	40	1.10±0.01	1.14±0.00	1.17±0.01	1.18±0.01	1.19±0.01	1.20±0.02	1.20±0.01
	60	1.18±0.02	1.26±0.01	1.29±0.02	1.32±0.03	1.33±0.01	1.33±0.02	1.34±0.02
	70	1.26±0.01	1.37±0.03	1.43±0.02	1.47±0.02	1.49±0.03	1.49±0.01	1.51±0.02
	75	1.30±0.02	1.42±0.02	1.50±0.03	1.53±0.02	1.55±0.02	1.57±0.01	1.56±0.02
	80	1.84±0.02	1.77±0.03	1.72±0.02	1.70±0.02	1.69±0.02	1.69±0.03	1.68±0.03
	85	1.98±0.03	1.89±0.02	1.85±0.05	1.84±0.02	1.81±0.02	1.82±0.03	1.81±0.03
350	40	1.09±0.01	1.12±0.01	1.15±0.01	1.18±0.01	1.18±0.05	1.19±0.01	1.20±0.01
	60	1.17±0.02	1.19±0.01	1.26±0.01	1.31±0.00	1.32±0.01	1.34±0.02	1.34±0.01
	70	1.23±0.02	1.29±0.02	1.36±0.02	1.44±0.01	1.45±0.04	1.48±0.02	1.49±0.02
	75	1.26±0.02	1.33±0.01	1.41±0.01	1.50±0.02	1.53±0.04	1.56±0.02	1.56±0.02
	80	1.86±0.03	1.82±0.03	1.77±0.02	1.73±0.03	1.71±0.03	1.68±0.02	1.67±0.02
	85	1.99±0.05	1.97±0.03	1.89±0.03	1.84±0.03	1.82±0.03	1.81±0.02	1.81±0.02

400	40	1.08±0.01	1.12±0.02	1.16±0.01	1.17±0.01	1.17±0.00	1.18±0.01	1.19±0.03
	60	1.16±0.01	1.21±0.01	1.28±0.02	1.30±0.02	1.31±0.02	1.33±0.03	1.34±0.01
	70	1.23±0.02	1.31±0.01	1.39±0.02	1.43±0.02	1.45±0.03	1.47±0.01	1.49±0.01
	75	1.24±0.01	1.33±0.01	1.45±0.02	1.48±0.01	1.52±0.02	1.54±0.02	1.56±0.02
	80	1.87±0.01	1.81±0.03	1.75±0.03	1.72±0.03	1.71±0.01	1.69±0.01	1.69±0.04
	85	2.01±0.01	1.94±0.01	1.86±0.03	1.84±0.01	1.84±0.05	1.84±0.01	1.82±0.02

Table S2. The measured values of the growth factors for NaCl-SOS single nano-particles of different organic volume fractions at different relative humidities after aging.

OVF(%)	RH(%)	GF(0h)	GF(2h)	GF(3h)
5	40	1.01±0.02	1.15±0.02	1.17±0.01
	60	1.01±0.01	1.28±0.02	1.33±0.02
	70	1.01±0.01	1.39±0.01	1.45±0.02
	75	0.99±0.01	1.46±0.02	1.54±0.02
	80	2.01±0.04	1.73±0.01	1.71±0.02
	85	2.15±0.03	1.89±0.03	1.82±0.03
10	40	1.02±0.02	1.15±0.01	1.17±0.02
	60	1.04±0.03	1.28±0.01	1.32±0.02
	70	1.00±0.02	1.40±0.02	1.47±0.03
	75	1.00±0.02	1.43±0.02	1.51±0.03
	80	2.01±0.02	1.75±0.02	1.71±0.02
	85	2.16±0.02	1.88±0.03	1.84±0.02
18	40	1.02±0.02	1.14±0.01	1.18±0.01
	60	1.02±0.02	1.28±0.03	1.32±0.02
	70	1.00±0.03	1.38±0.02	1.45±0.01
	75	1.01±0.02	1.44±0.02	1.50±0.02
	80	2.00±0.02	1.76±0.03	1.71±0.02
	85	2.15±0.01	1.86±0.01	1.84±0.05
33	40	1.01±0.01	1.14±0.02	1.18±0.02
	60	1.02±0.01	1.23±0.03	1.31±0.02
	70	1.02±0.01	1.36±0.02	1.42±0.02
	75	1.00±0.02	1.42±0.04	1.51±0.02
	80	2.02±0.02	1.76±0.02	1.73±0.02
	85	2.14±0.03	1.93±0.01	1.84±0.03
50	40	1.02±0.01	1.12±0.02	1.16±0.01
	60	1.01±0.01	1.23±0.02	1.26±0.03
	70	0.99±0.03	1.33±0.01	1.40±0.02

	75	1.02±0.01	1.37±0.01	1.44±0.02
	80	2.02±0.01	1.78±0.02	1.74±0.01
	85	2.16±0.02	1.91±0.04	1.89±0.01
70	40	1.02±0.02	1.07±0.01	1.12±0.02
	60	1.00±0.01	1.11±0.02	1.20±0.01
	70	0.99±0.03	1.13±0.02	1.27±0.02
	75	1.00±0.02	1.17±0.01	1.31±0.02
	80	2.02±0.03	1.92±0.01	1.81±0.01
	85	2.15±0.01	2.04±0.03	1.97±0.01