

## Electronic Supplementary Information (ESI)

### **Synergistic CuO/MgO Nucleation for Low-Supercooling Na<sub>2</sub>SO<sub>4</sub>·10H<sub>2</sub>O in Battery Thermal Management**

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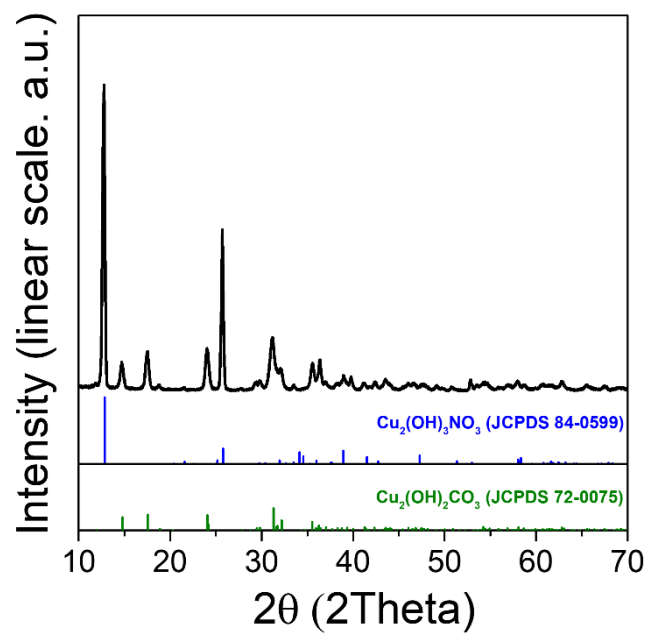


Fig. S1 XRD pattern of  $\text{Cu}_2(\text{OH})_3\text{NO}_3$  and  $\text{Cu}_2(\text{OH})_2\text{CO}_3$  precursor nanostructures before calcination.

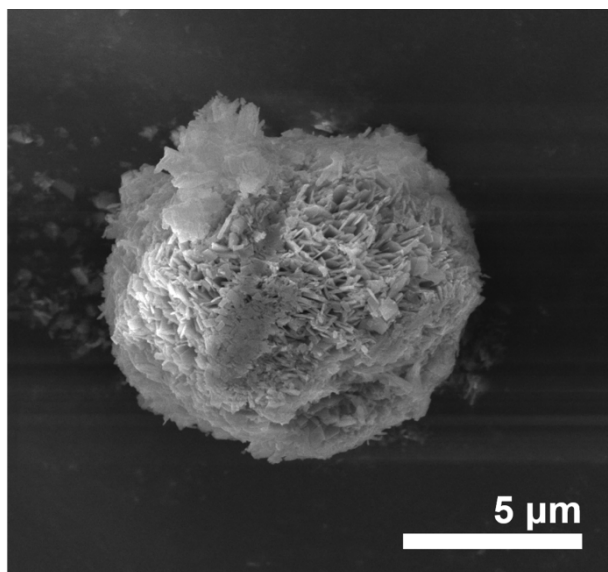


Fig. S2 SEM image of Cu-based Nanoflower Precursor before calcination.

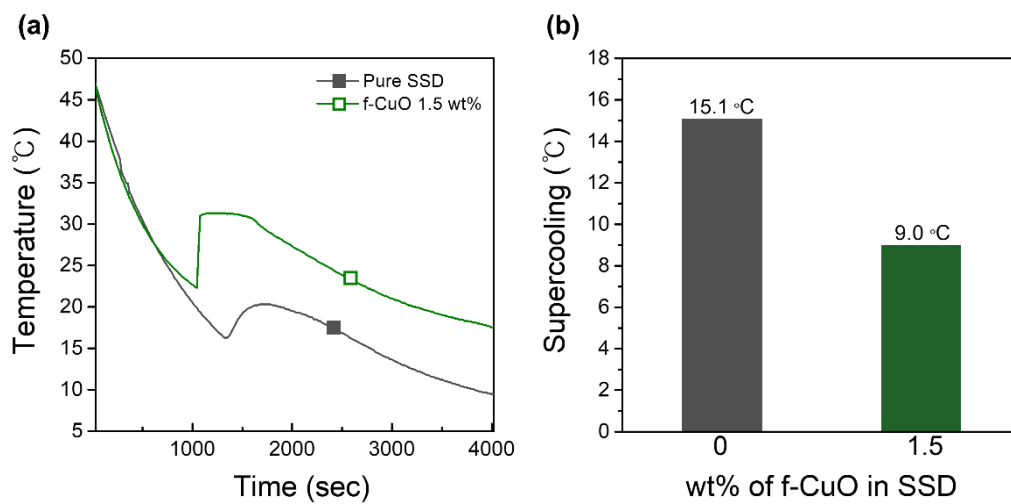
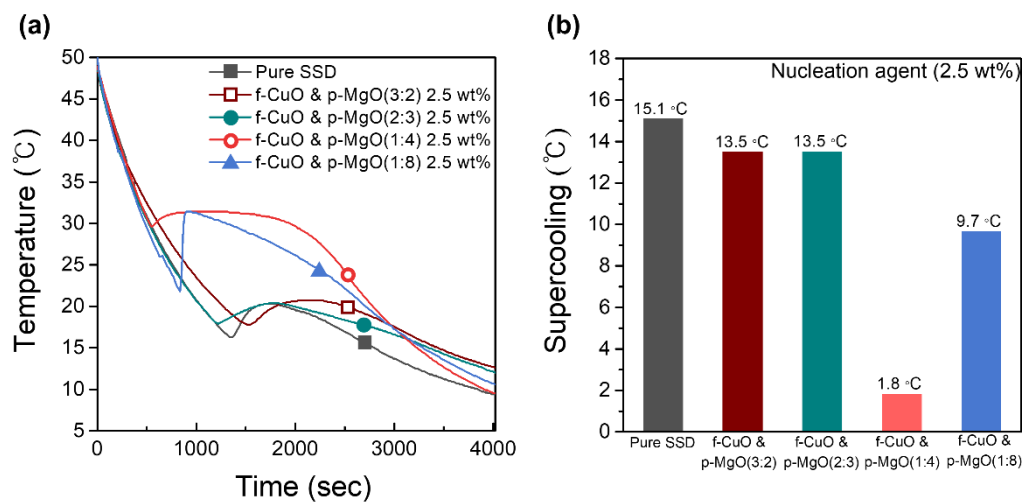


Fig. S3 Cooling curve data. (a) Cooling curve for f-CuO 1.5 wt% and (b) Supercooling degree at Pure SSD and f-CuO 1.5 wt%.

Fig. S4 Cooling curve data. (a) Cooling curve for different ratios of f-CuO and p-MgO (2.5 wt%), and (b) Supercooling degree at different ratios of f-CuO and p-MgO (2.5 wt%).



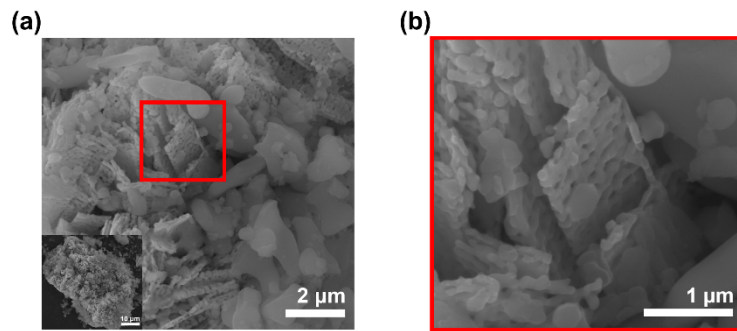
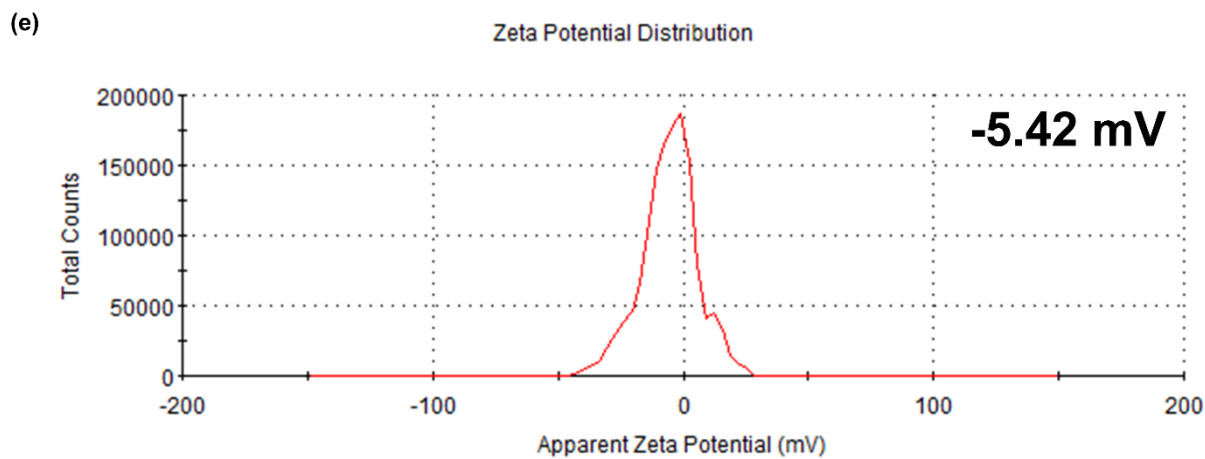
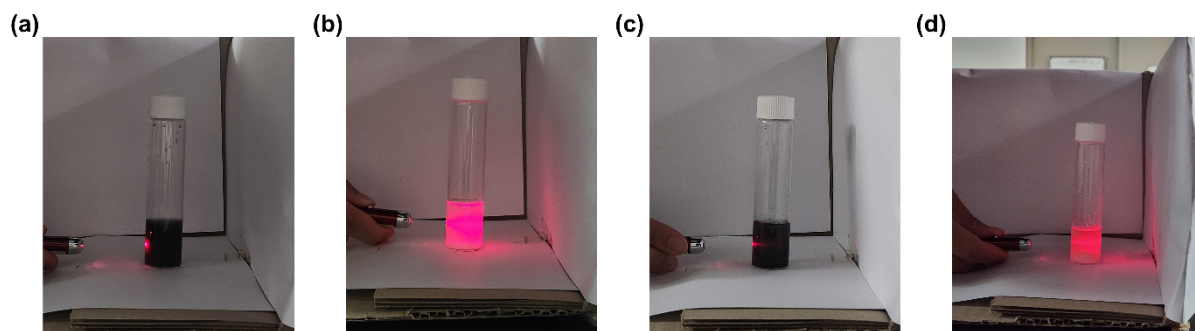


Fig. S5 SEM image of SSD grown on the nanoplates of f-CuO, and (b) High magnification SEM image of the red-boxed area in (a)



**Fig. S6 (a) Photograph of f-CuO (0.5 g), (b) p-MgO (0.5 g) and (c) f-CuO:p-MgO (1:4, total 0.5 g) dispersed in DI water (15 mL) under red laser irradiation for comparative assessment of dispersion behavior. (d) Photograph of molten Pure SSD (20 g) under red laser irradiation for comparative assessment of dispersion behavior. (e) Zeta potential analysis of f-CuO & p-MgO(1:4) in water.**

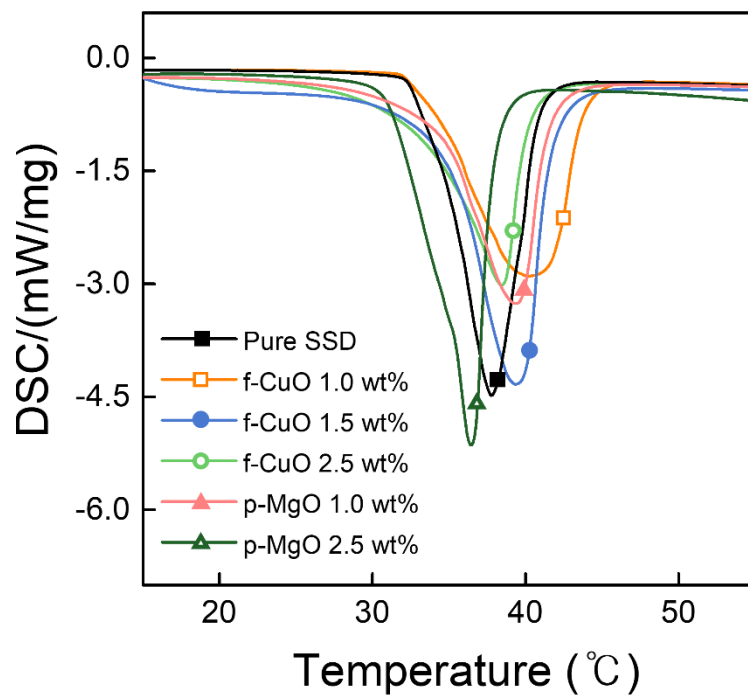


Fig. S7 DSC curves of pure SSD and SSD composites containing f-CuO (0-2.5 wt%), p-MgO (0-2.5 wt%).

**Table S1 Standard deviation values used for the error bars in Fig. 3(f).**

Nucleation agent condition	Supercooling degree standard deviation (°C)
Pure SSD	0.10
f-CuO 2.5 wt%	1.19
p-MgO 2.5 wt%	0.10
f-CuO & p-MgO(1:4) 2.5 wt%	0.15

**Table S2 Comparison of Latent Heat for Different Nucleation Agents.**

Sample	Latent heat ( $\Delta H$ ) [ $Jg^{-1}$ ]
Pure SSD	-222.9
SSD + 1.0 wt% f-CuO	-220.2
SSD + 1.5 wt% f-CuO	-193.2
SSD + 2.5 wt% f-CuO	-175.6
SSD + 1.0 wt% p-MgO	-195.2
SSD + 2.5 wt% p-MgO	-206.5

**Table S3 Comparison of nucleation agents for SSD nucleation**

Primary nucleation agent	Secondary additives	$\Delta T_s$ (°C)	Latent heat (J g <sup>-1</sup> )	Reference
Borax	NFC, Graphite	3.6	121.1	1
Borax	Graphene nanoplatelets	5.1	217.1	2
Borax	Al/C nanoparticle	2.2	206	3
Borax	CMC, EG	8.03	114.0	4
Borax, ZnO	CMC	3.3	210.6	5
SiC	-	21.2	184.8	6
Boron Nitride	-	1.91	214.4	7
f-CuO & p-MgO	CMC	1.8	184.8	This work

**Table S4 Temperature standard deviation values of pure Al-ad used for the error bars in Fig. 7(d).**

Time (sec)	Temperature standard deviation (°C)
240	0.321
480	0.153
720	0.20
960	0.173

**Table S5 Temperature standard deviation values of SSD-C coated Al-ad used for the error bars in Fig. 7(d).**

Time (sec)	Temperature standard deviation (°C)
240	0.252
480	0.208
720	0.153
960	0.100
1260	0.173

## Notes and references

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