Supporting Information

for Adv. Sci., DOI 10.1002/advs.202204633

Room Temperature Halide-Eutectic Solid Electrolytes with Viscous Feature and Ultrahigh Ionic Conductivity

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Figure S1. SEM image of AG91 with a higher magnification.
Figure S2. EIS Nyquist plots of 2LiCl-\(x\)AlF\(_3\)-(1-\(x\))GaF\(_3\) (0.5\(\leq x \leq 0.9\)) prepared with ball milling time of 6h. a) AG55. b) AG64. c) AG73. d) AG82. e) AG91.
Figure S3. Ionic conductivity of $2\text{LiCl} - x\text{AlF}_3 - (1-x)\text{GaF}_3 \ (0.5 \leq x \leq 0.9)$ prepared with different ball milling times (6 and 12 h).
Figure S4. EIS Nyquist plot of AG73 at -20 °C.
Figure S5. SEM image of AG55 after air-exposure. The EDS point analyses were performed on the selected spots from #1 to #6. The corresponding EDS elemental data are listed in Table S2.
Figure S6. Aqueous sensitivity test of AG55. a) Pristine state. b) Exposed in air for 30 min.
Figure S7. Ionic conductivity of AG73 as a function of air-exposure time.
**Figure S8.** Cryo-TEM measurement. The selected rough area (left panel) and the corresponding SAED pattern (right panel).
Figure S9. STEM-HAADF and EDS mapping images for AG55.
Figure S10. Chemical stability of AG73 toward Li metal. The surface of the Li metal turns black after contacting with AG73 for 1 h.
Figure S11. Evaluations on LFP. a) Optical photograph of the powders. b) Thickness of the pellet cold-pressed from the powders (60 mg). c) SEM image of the pellet. d) Nyquist plot of the pellet. e) DC polarization curve of the pellet.
Table S1. EDS point analysis of AG55 shown in Figure 3a.

| Spot | Ga    | F     | Al    | Cl    |
|------|-------|-------|-------|-------|
| 1    | 8.64  | 33.92 | 8.11  | 40.44 |
| 2    | 7.58  | 33.83 | 7.70  | 40.37 |
| 3    | 7.02  | 38.35 | 8.15  | 38.22 |
| 4    | 5.30  | 28.90 | 6.72  | 26.33 |
Table S2. EDS point analysis of air-exposed AG55 shown in Figure S4.

| Spot | Ga | F  | Al | Cl  |
|------|----|----|----|-----|
| 1    | 75.27 | 0.00 | 1  | 128.94 |
| 2    | 1.28  | 2.78 | 1  | 3.94  |
| 3    | 1.31  | 3.78 | 1  | 3.41  |
| 4    | 1.31  | 3.33 | 1  | 3.60  |
| 5    | 1.18  | 2.26 | 1  | 5.34  |
| 6    | 0.89  | 1.74 | 1  | 3.87  |