Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supplemental Information

Optimizing Pulsed-Laser Ablation Production of AlCl Molecules for Laser Cooling

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Sample Target **Mapping**

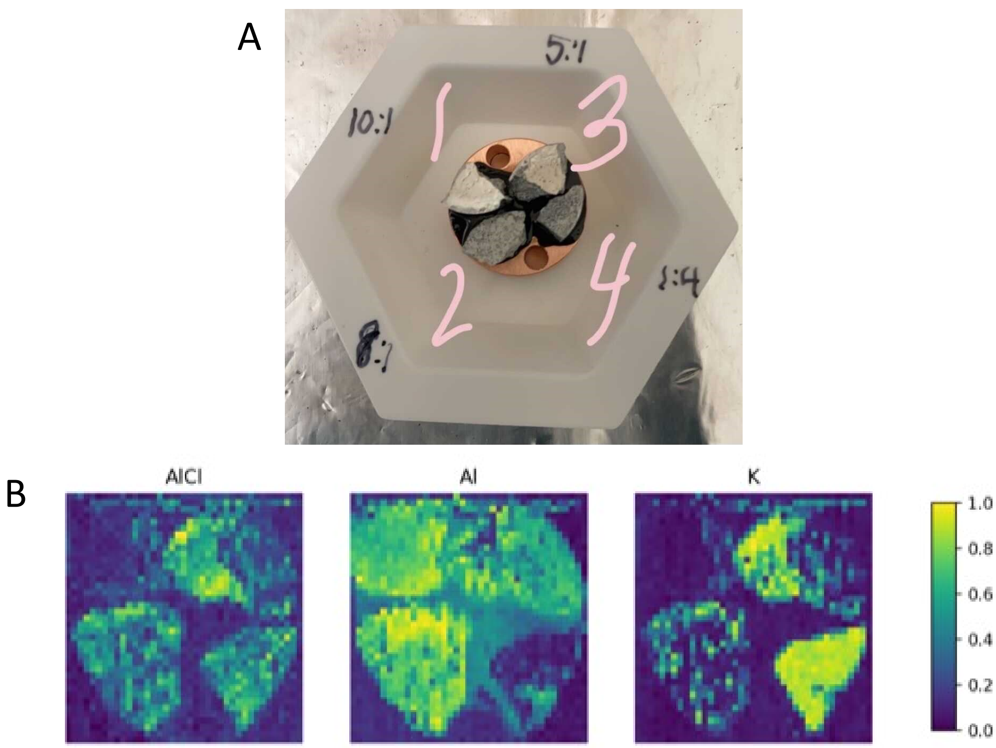
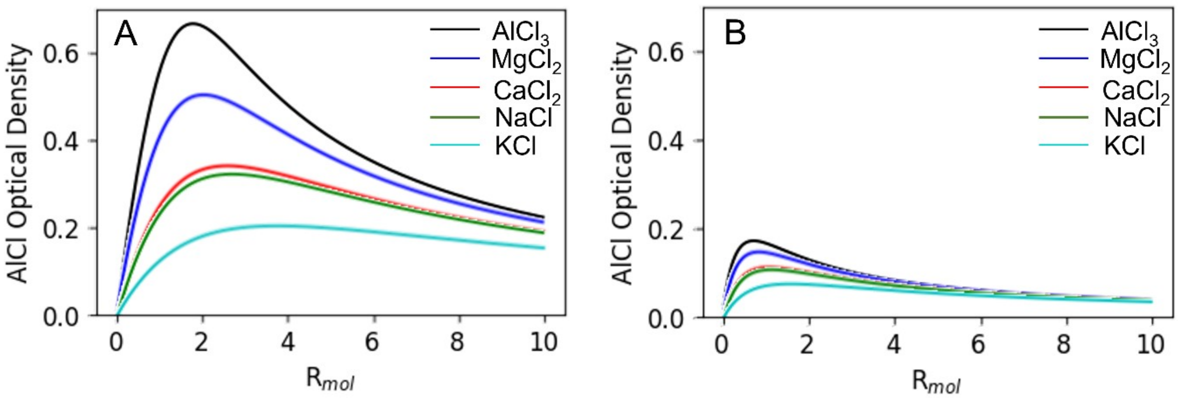


Figure S1. (A) Sample target with various Al:KCl molar ratios, as labelled in pink (1) 10:1, (2) 8:1, (3) 5:1, and (4) 1:4. (B) Target mappings for absorption of AlCl, Al, and K. The color map on the right shows the variation in AlCl absorption from 0 (dark blue) to 1 (yellow).



Simulated XCl_n Sources

Figure S2. Simulated R_{mol} curves for different XCl_n sources from Model A (A) and Model A' (B). With a fixed scaling factor (γ), the optical density of each source in Model A is roughly 3 times larger than Model A' due to the aluminum recondensation.

Table S1. The R_{mol}^{max} found for each XCl_n source from Model A and Model A'. These values are used to plot against the ρ_{Cl} in Figure 7B.

	Model A	**Model A'**
	R_{mol}^{max}	R_{mol}^{max}
KCl	3.75	1.55
NaCl	2.69	1.11
$CaCl_2$	2.58	1.07
$MgCl_2$	2.39	0.99
$AlCl_3$	1.79	0.74

Average Absorption from Time-Dependent Traces

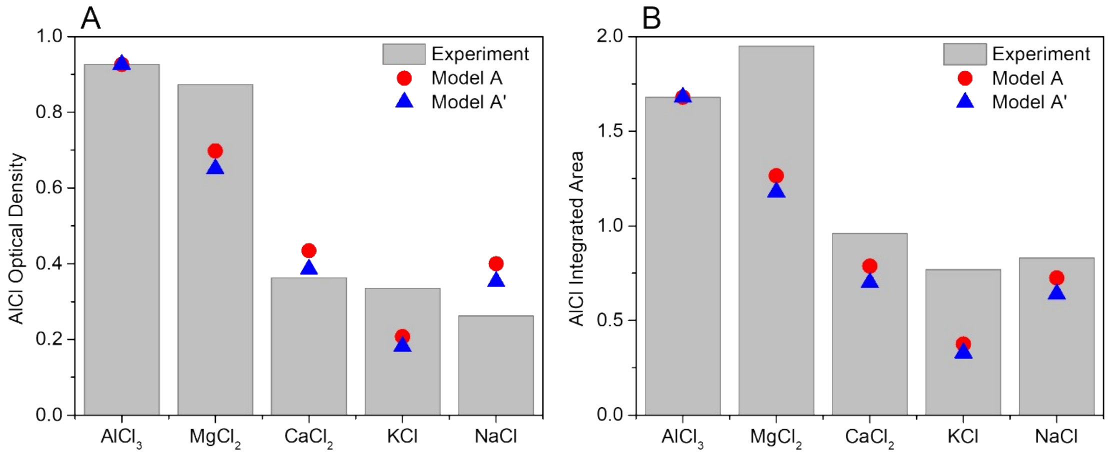


Figure S3. Theory is compared to the experimental optical density signal from each chloride source at R_{mol} = 0.25. The experimental date is acquired by taking the peak optical density value from each time trace (A) and integrated over the time trace (B). Models A and A' are normalized to the $AlCl_3$ optical density.

Al Density Calculation

If we assume our ablation crater to be cone-shaped, we can calculate the volume of the ablation cone estimating a crater depth of 6 μm[1] and our known ablation laser spot size of 80 μm.

$$V = \frac{1}{3}\left[\frac{1}{2}\pi r^2\right]h$$

The resulting volume of sample ablated is $5.03 \cdot 10^{-9}$ cm^3. Then we can use this volume and stoichiometrically convert aluminum density to moles of aluminum in the gas phase after ablation,

$$2.70\, {}^{g}\!/_{cm^3} \times 5.03 \cdot 10^{-9}\, cm^3 \div 26.98 {}^{g}\!/_{mol} \times {}^{6.022 \cdot 10^{23}}\!/_{mol}$$

to get $3.03 \cdot 10^{14}$ atoms. We can then use our known volume of our cell (28 cm^3) to calculate the maximum Al density after ablation,

$$\frac{3.03 \cdot 10^{14}\, atoms}{28\, cm^3}$$

And our result is $1.1 \cdot 10^{13}\, {}^{atoms}\!/_{cm^3}$.

References

(1) U.P.B. Sci. Bull., Series A, Vol. 70, Iss. 4, 2008