Chemical Composition from Photos: Dried Solution Drops Reveal a Morphogenetic Tree

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Abstract

- Key question: Can chemical composition be predicted from macroscopic crystallization patterns?
- We collect 7500 photos of 42 different dried salt solutions
- Using in-house MATLAB scripts, 16 characteristics (size, holes, eccentricity etc.) are obtained for each deposit pattern.
- Machine learning algorithms yield prediction accuracies of over 90% (75% for $N = 14$).
- Salt mixtures appear to be more challenging.

Method

Crystallization

1. Preparation:
   - Create a saturated salt solution
   - Wipe glass slides with pure ethanol
   - Pipette 3 separate drops of 10 µL of salt solution onto the glass slide
   - Wait the allotted time for the salt structure to crystalize
2. Collection:
   - Collect slide samples
   - Prepare camera and software system
   - Capture individual salt patterns

Analysis

1. Separation
   - Convert to grayscale images, then apply a threshold to create binary versions where white (“1”) regions are the deposit
2. Calculations
   - Obtain perimeter, area, etc. for data reduction
3. Quantitative Comparisons
   - Apply PCA, MDS, and other analysis methods to characterize the different salts and formulate predictions

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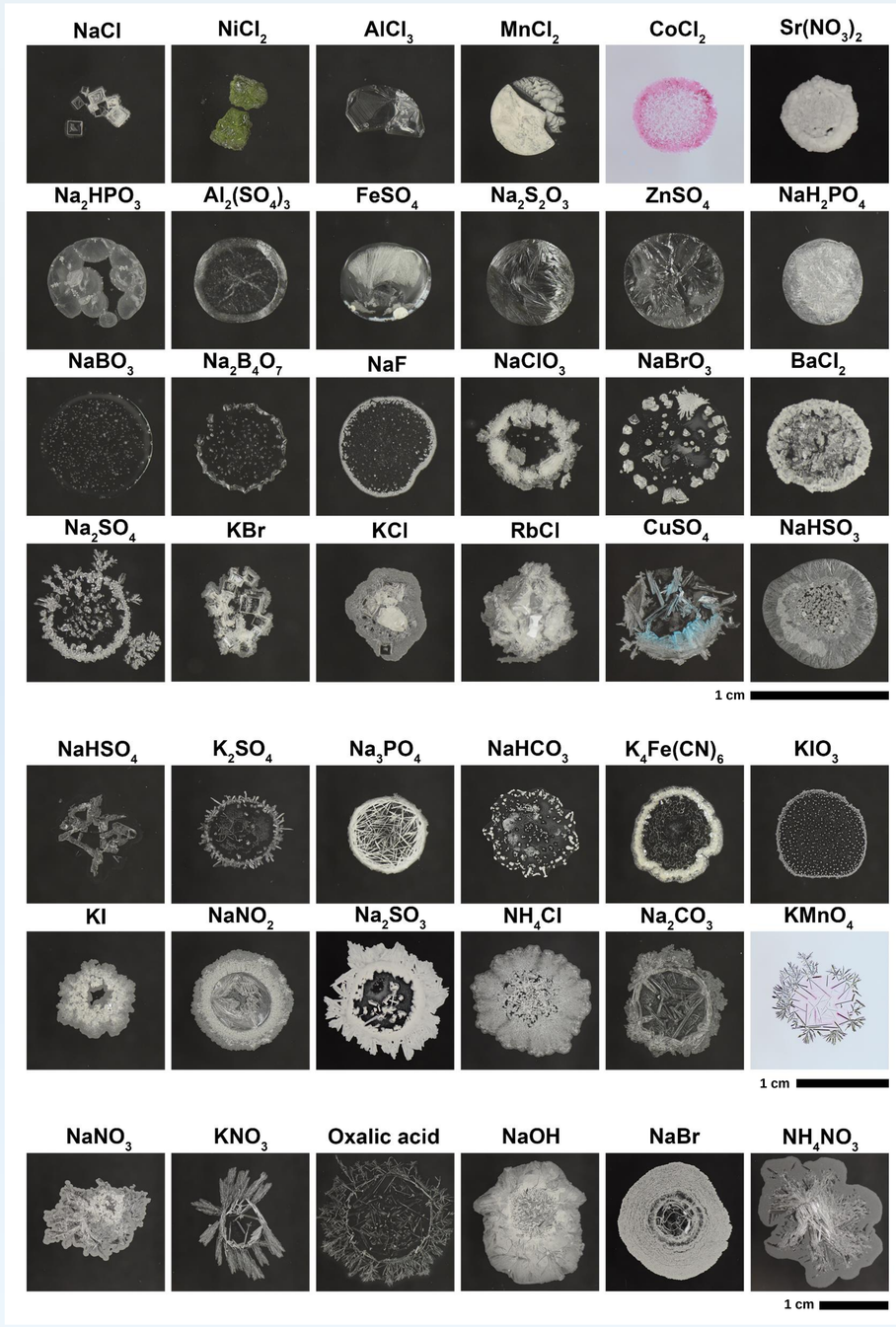
References

Batista, B., Tekle, S, Yan J, Dangi, B, Steinbock, O. (2024). Chemical composition from photos: Dried solution drops reveal a morphogenetic tree. [Manuscript submitted for publication].

Representative Deposit Patterns



Analysis Results