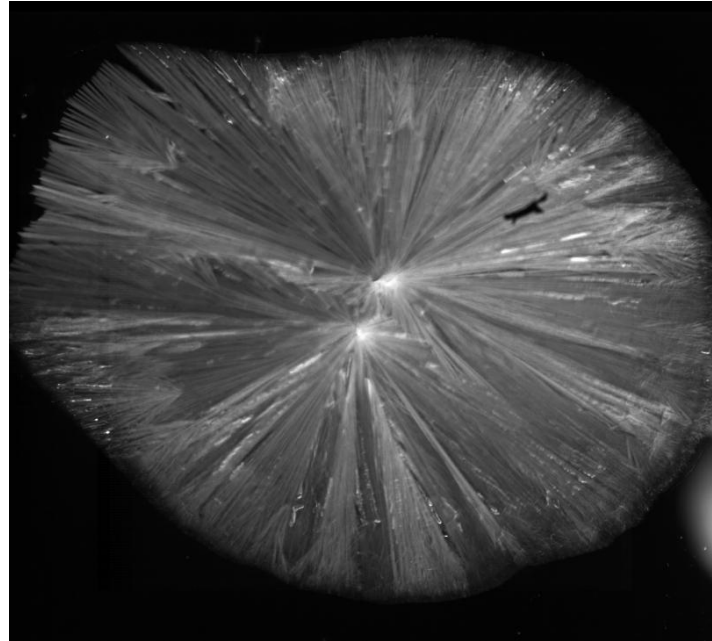


High Speed Crystallization



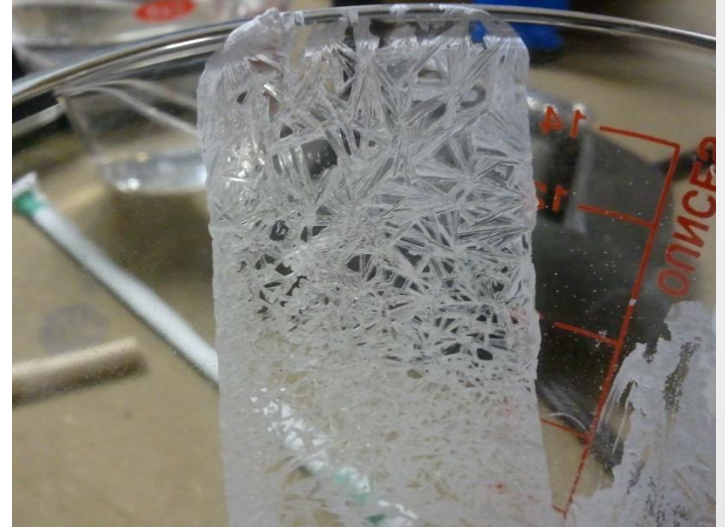
Crystallization of supersaturated Sodium Acetate solution from below. The two points of emanation caused by two seeds are clearly visible. Shot at 1000 fps, f/8, 90mm lens.

Background: crystallization

- Crystallization refers to the formation of solid crystals from a homogeneous solution.
- It is essentially a solid-liquid separation technique and a very important one at that.
- Solubility - Hot liquid dissolves more compounds. Once cooling process starts, compounds become crystals

Background: sodium acetate

- Sodium acetate (NaAc) can perform rapid crystallization when supersaturated
- Supersaturation is when more solute than is normally possible is dissolved into a solvent
 - Can be achieved by increasing temperature
- If a supersaturated solution of NaAc is slowly cooled, it can be rapidly crystallized if perturbed or given a nucleation site



[1] <http://jchemed.chem.wisc.edu/JCESoft/CCA/CCA3/MAIN/ACETATE/PAGE1.HTM>

Background: bismuth

- White/silverish, crystalline, brittle, very dense, highly diamagnetic metallic element
- Very sensitive to high temperatures
- Very viscous and cools rapidly
- Pretty colors and cool shapes

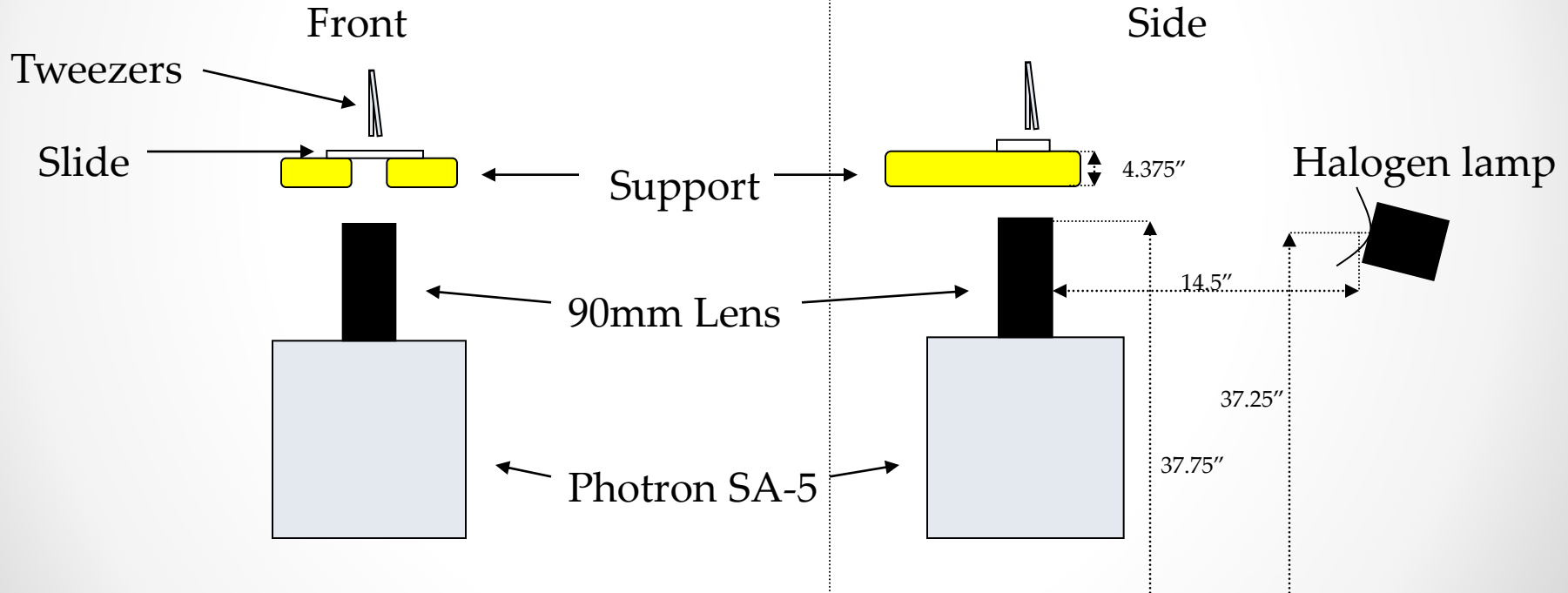


1. <http://www.facts-about.org.uk/science-element-bismuth.htm>
2. http://upload.wikimedia.org/wikipedia/commons/6/65/Bismuth_Crystal.jpg

Goals:

- Observe crystallization process
 - Targets: Sodium Acetate, Bismuth
- Make measurements of speed and process of crystallization
- Determine feasibility of future quantitative studies

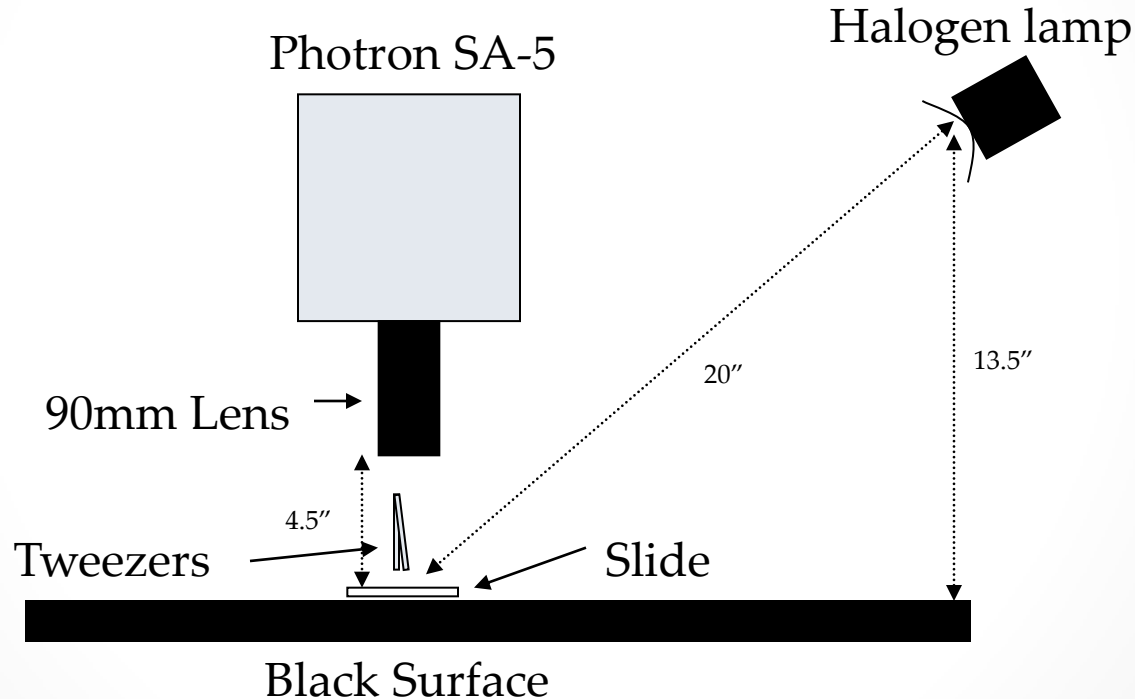
Procedure: underneath setup



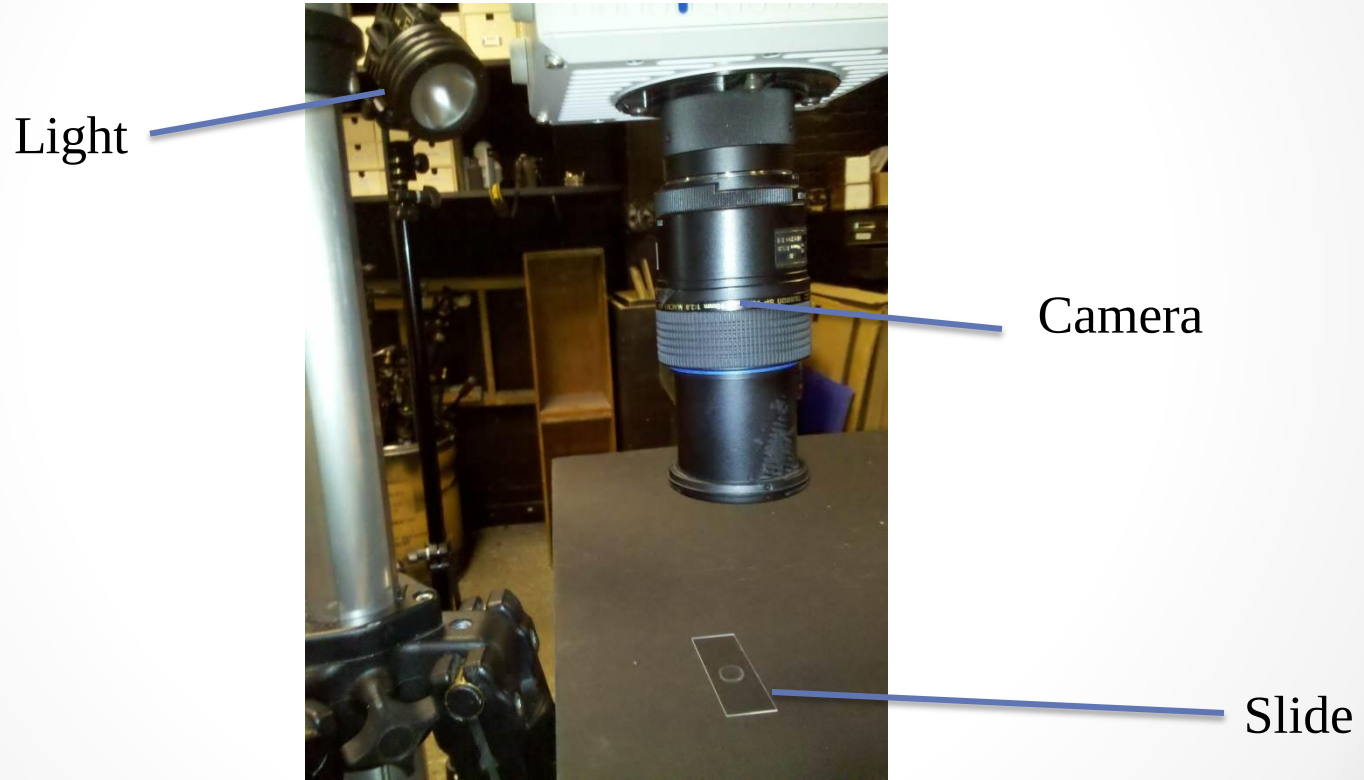
Procedure: underneath setup



Procedure: overhead setup

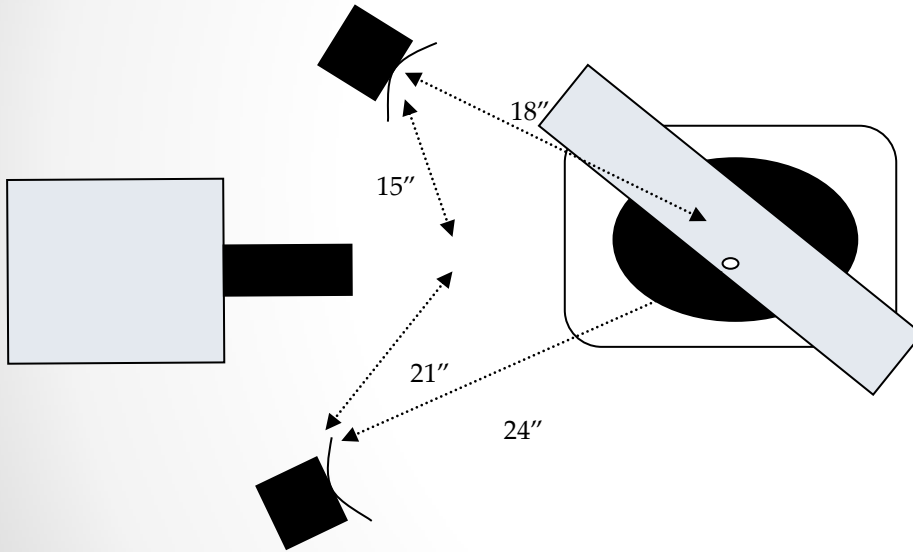


Procedure: overhead setup

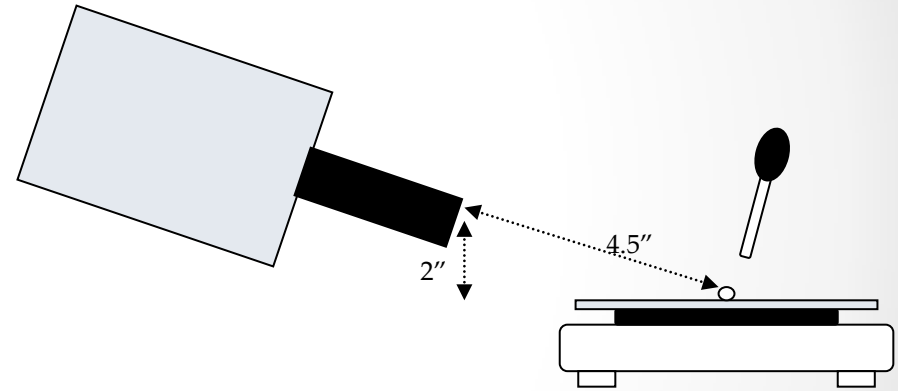


Procedure: boiling setup

Top



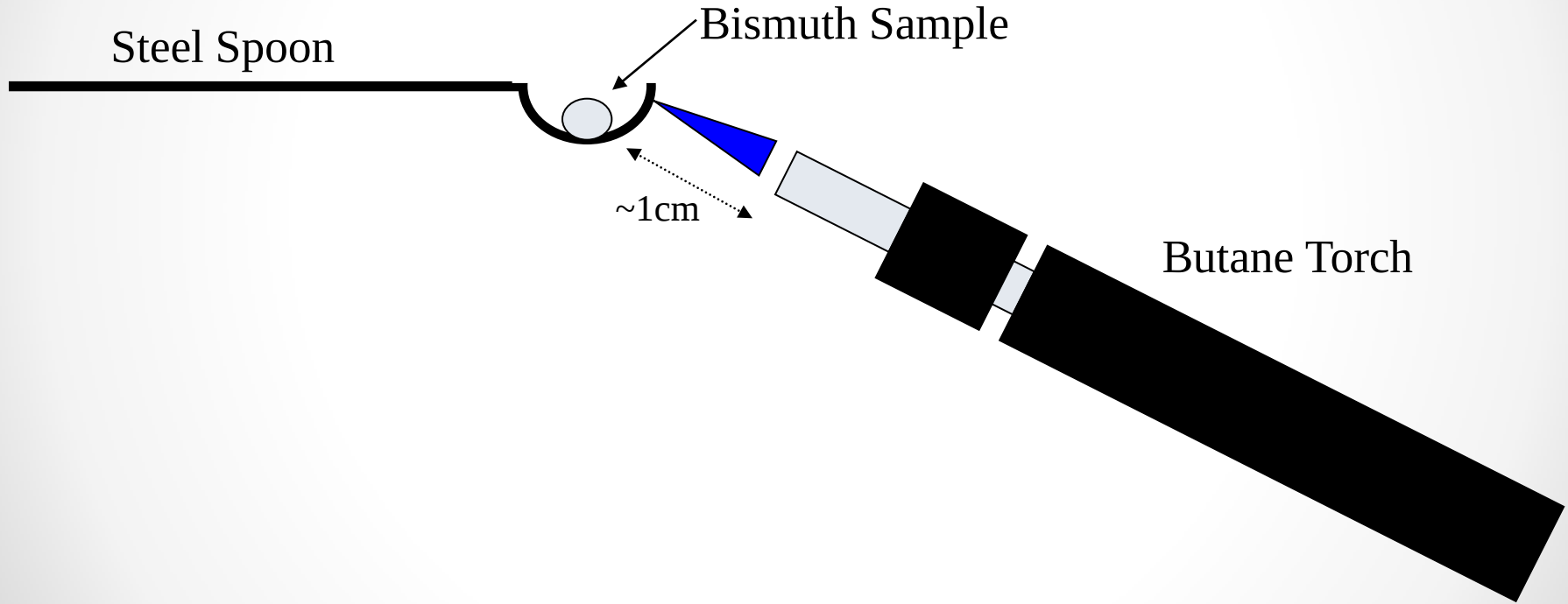
Side



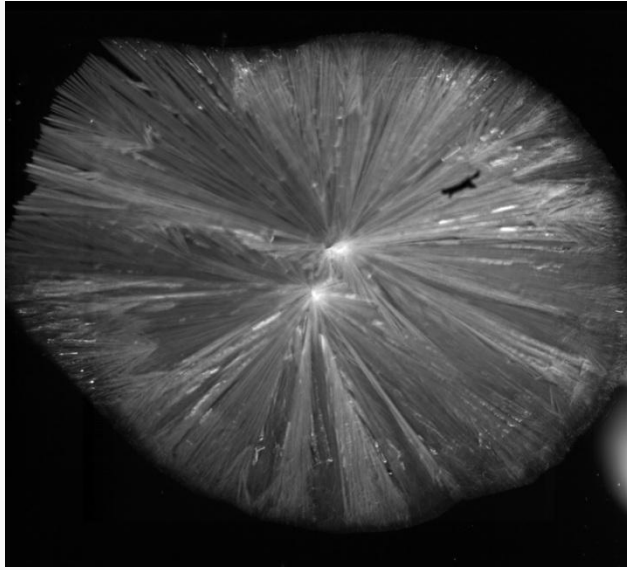
Procedure: boiling setup



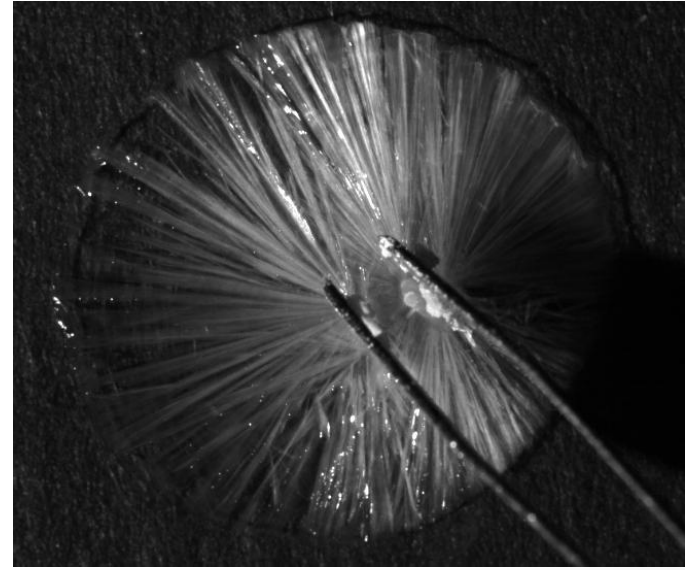
Procedure: bismuth setup



Results

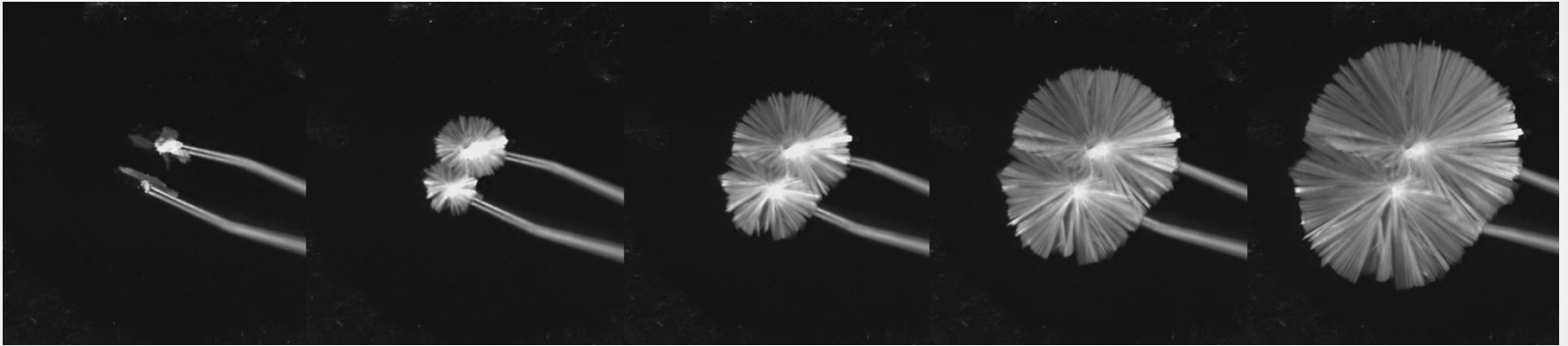


Crystallization of supersaturated Sodium Acetate solution from below. Three drops from an eyedropper. Two points of emanation. Shot at 1000 fps, f/8 90mm lens.



Crystallization of supersaturated Sodium Acetate solution from above. Crystals appear to be on top of the solution. Three drops from an eyedropper. Two points of emanation. Shot at 1000 fps, f/11, 90mm lens. Brightness increased 30% for clarity.

Results



Five frames of Sodium Acetate crystalizing from below. Each frame is .2 seconds apart, all five frames span .8 seconds.
Shot at 1000 fps, f/8, 90mm lens.

Results



Close up of solidified bismuth. Color variation from crystal formation is visible. Size is roughly ~3 mm across. f/16, 90mm lens

Results



Solidified bismuth drop. Drop was melted in a spoon then poured onto a slide. The line across the middle of the image is the edge of the slide that the drop landed on. Many colors are visible along the various surfaces. f/36, 90mm lens.

Discussion: summary

Sodium Acetate:

- Crystals form radially outward from seed
- Crystals are long and skinny prisms
- Crystal formation pattern depends on how crystallization is triggered

Bismuth:

- Difficult to form nice looking bismuth crystals
- Colors won't show up on monochrome high-speed
- No crystal forming process static enough to record

Discussion: conclusions

- Sodium Acetate is feasible
 - Crystallizes consistently and on recordable time scales
- Bismuth isn't feasible
 - Crystallization isn't happening on time/physical scales we have the techniques to record

Discussion: moving forward

With sodium acetate:

- vary temperature/concentration, look at linear crystallization speed (see 1957 paper)
- look at types/processes of crystallization