Fluorescence of Silver Nanoparticles in Polymer Solutions for Direct Write Technologies

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Research Objectives

- Research and use only non-toxic chemicals.
- Conduct experiments to find an ideal solvent to be used in thin film polymer production.
- Dissolve PMMA into solution and disperse silver nanoparticles into same solution.

Procedure

Evaluation Testing

- Varying solvents placed in containers and continuously weighed, weights of solvent checked in time intervals and were recorded.
- Testing concluded when solvents reached weights of 1.0g or below.

Solubility Testing

- Varying solvents mixed with PMMA powder (Figure 1). After powder dissolution, additional powder added successively.
- Testing concluded when solvent could no longer dissolve PMMA. Time was noted and final powder weight taken.
- Solute poured into dish, evaporation of PMMA-saturated solution observed.
- Drop-test then conducted, solutions dropped to evaporate on Kapton (Figure 2).

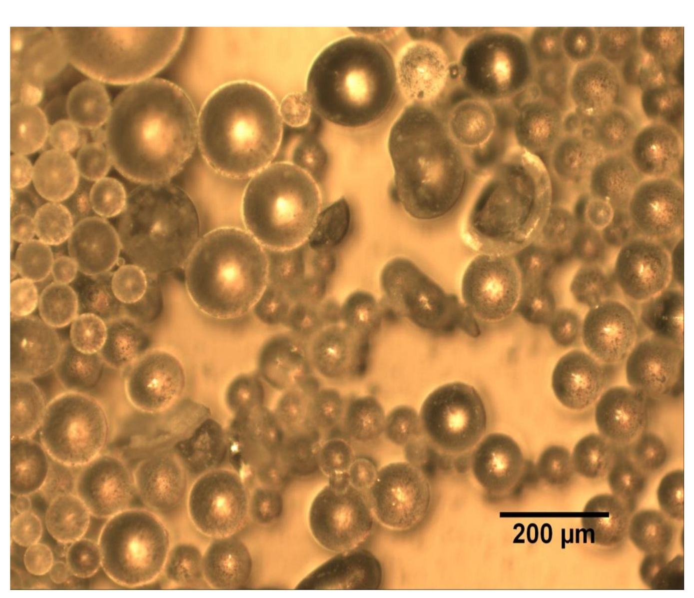

Figure 1: PMMA particles at 10x

Figure 2: Kapton with MEK/PMMA drop test

Abstract

Silver nanoparticles can be mixed into a polymer matrix solution to exhibit luminescent properties. This luminescence can be integrated into existing photovoltaic systems and can eventually serve as a substitute for silicon in today's solar cells. In this work, various solvents were tested to observe their evaporation rates and the solubility limits of PMMA powder. The goal of this research is to disperse previously synthesized silver nanoparticles and dissolve PMMA into solution. The solution will then be printed onto a substrate via Direct Write machines for a uniform layer. The expectation is that with the correct solvent, the solvent will evaporate from the substrate. This will leave solely the polymer and silver on the substrate, giving the user a thin polymer film with enhanced fluorescent properties.

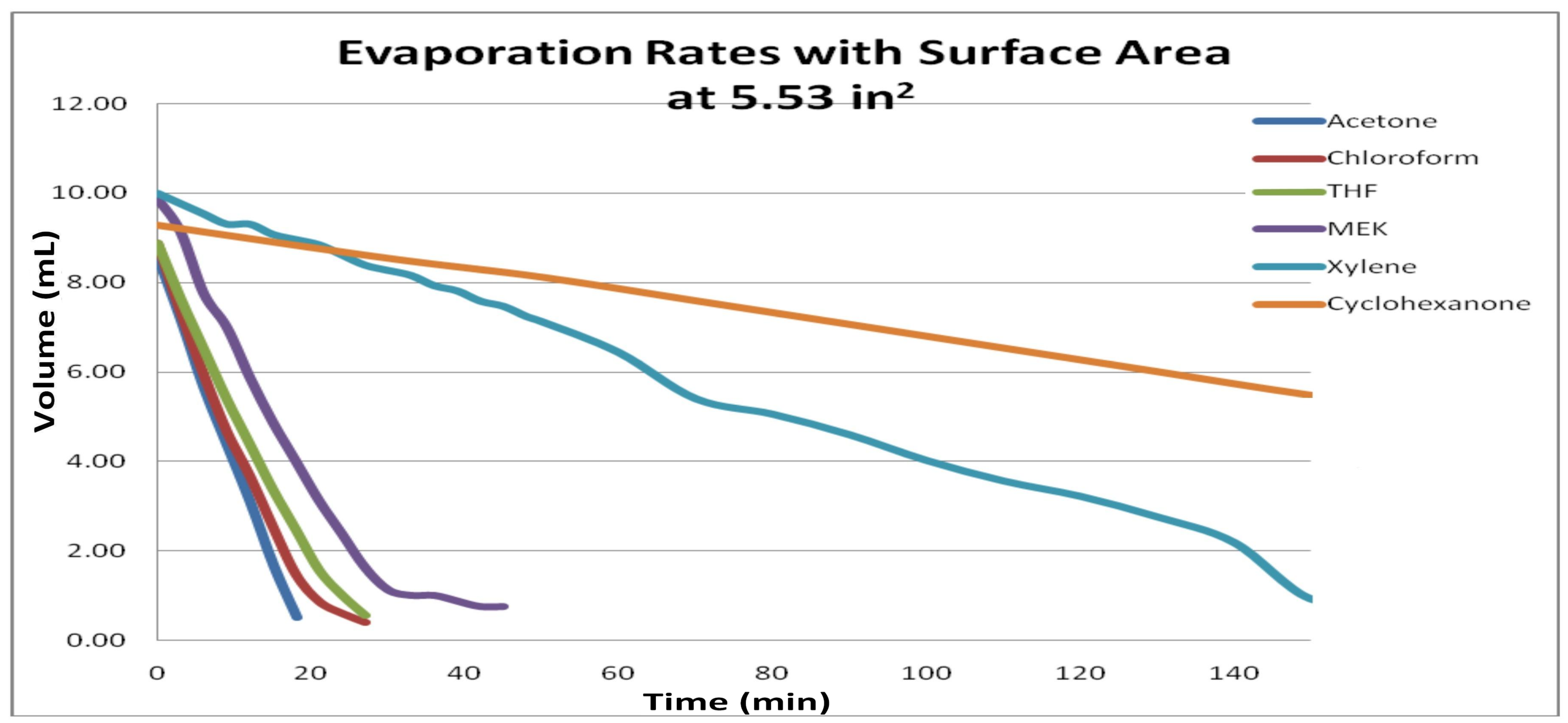

Figure 3: Plot of evaporation rates for all solvents involved in trial 2

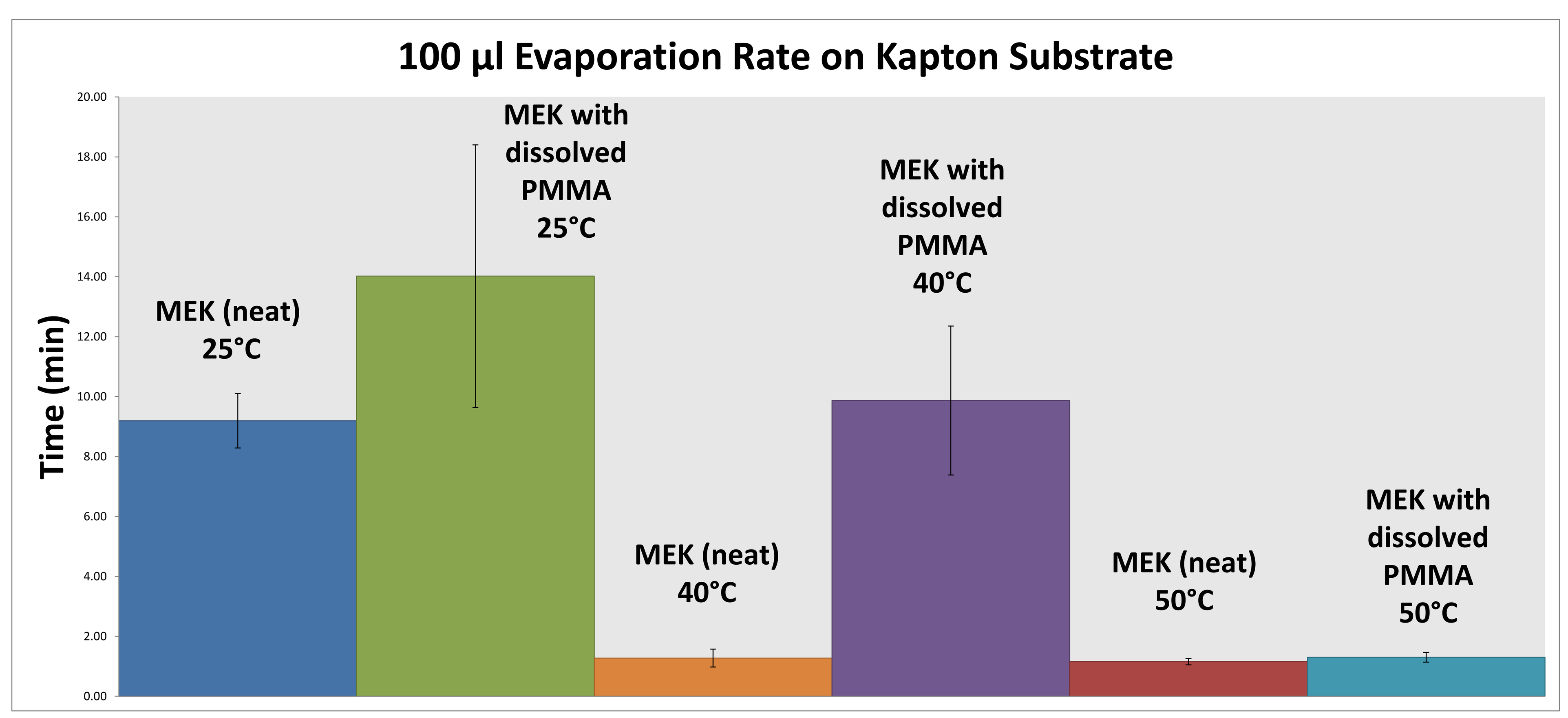

Figure 4: Drop-test results of MEK and MEK/PMMA at various temperatures

Results

- In second round of evaporation testing, all solvents completely evaporated and gave a hypothetical rate (Figure 3).
- Drop testing of MEK and MEK/PMMA solutions show that at elevated temperatures, solvents evaporate faster. The quickest evaporation came from MEK/PMMA at 50˚C (Figure 4).
- Solubility testing showed PMMA in 10mL chloroform had highest solubility limit: 1.347g (Figure 5).

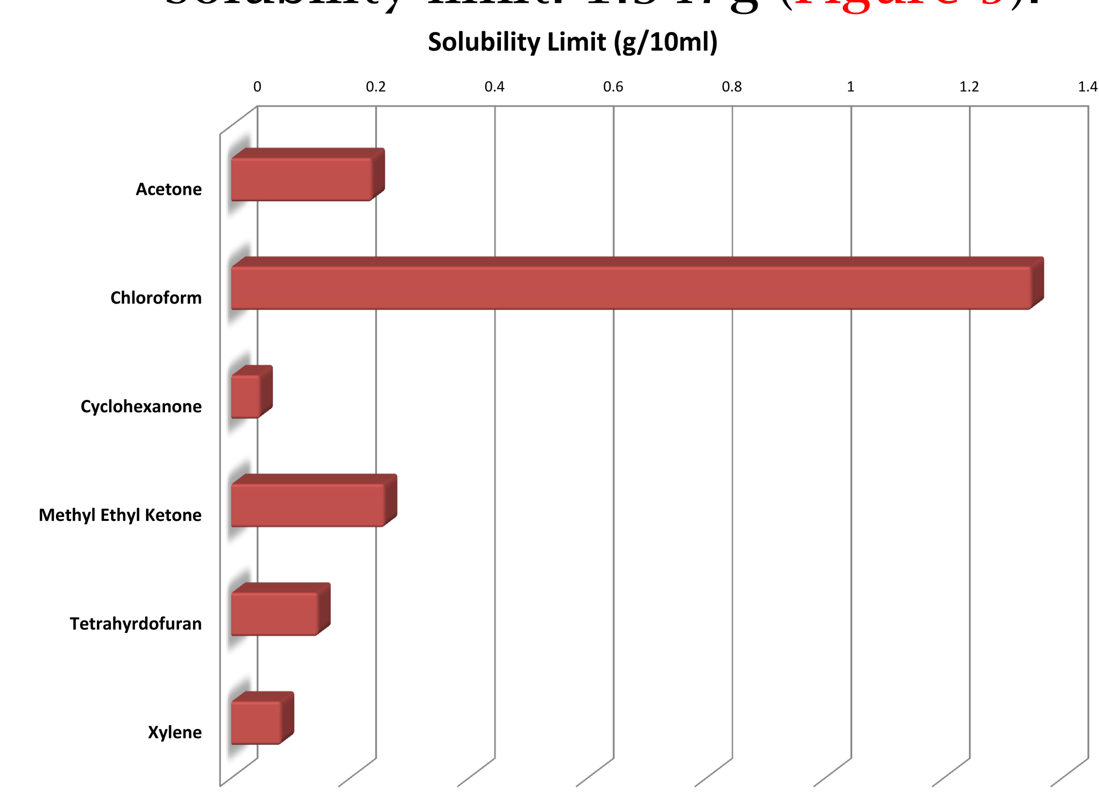

Figure 5: Plot of PMMA solubility limits

Conclusions

- Based on solubility and evaporation parameters, as well as the hazards of each solvent, it was determined that MEK should be used in conjunction with PMMA for thin film polymer formulation.

Future Work

- Solvent viscosity testing with rheometer.
- Solvent surface tension testing
- Ink formulation, according to Hansen Thesis, observe interaction between MEK/PMMA with silver nanoparticles.
- Direct Write printing of inks.
- Ink and substrate testing for enhanced fluorescence.

Acknowledgements

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