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Title: NMSBA Leveraged Project Interim Status Report

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NMSBA Leveraged Project Interim Status Report

1. Provide a brief summary of the work completed to date:

We have investigated the quality of copper particles available on the market today and determined their complete unsuitability to be used for copper inks, since all of them were significantly oxidized: there was only 50% of metallic copper in each batch and the rest was Cu₂O and CuO.

To date, we have fully identified the challenges and developed the synthesis for large amounts of the copper ink precursor, namely, copper(I) mesityl. Currently, the amounts of tens of grams of the precursor have been obtained.

From this precursor, four small batches of copper nanoparticles (50 mg each) have been synthesized to investigate the possibility of decreasing particle sensitivity to oxygen. These particles have been treated with different surface-stabilizing agents (namely, octylamine, oleylamine, pyridine, benzotriazole, and dodecanethiol) in order to investigate their influence on particle oxygen sensitivity.

A batch of copper nanoparticles in the amount of 2grams has also been synthesized in order to start preparation of test ink batches with different solvents, surfactants, and stabilizers.

2. Provide a brief summary of any issues encountered:

The main issue we have encountered was the challenge to synthesize large amounts of CuMes. Namely, each reaction yielded very low percentage of the final product due to the prevalence of a side reaction. Several attempts of the synthesis have been undertaken before the yield of the procedure was increased to 90-93%.

The second issue was the challenge of nanoparticle handling outside of the inert atmosphere box. The rate of copper particles oxidation is inversely proportional to their size, so we focused on the synthesis of 20nm particles to minimize the effects of oxidation.

3. Provide a brief summary of any communications with the small business POC:

Email and phone conversations with the small business POC have been conducted during the whole duration of the project. POC also twice visited the lab where the particles have been synthesized and tested.

4. Compare actual progress to spending and planned progress:

- *Approximate percent spent: 100%*
- *Approximate percent complete: 70%*

- *Planned percent complete, based on milestones: 70%*

5. Compared to milestones submitted with your proposal, are you on track? Yes No

If no, explain: Significant delay with the synthesis of copper particle precursor and challenges with handling the air-sensitive particles efficiently put us behind the schedule.

Although the funding of the project has ran out earlier than we planned, the project itself is being continued under the authorization of CINT user proposal program and we believe that all milestones of the proposal will be hit before the end of this year.

6. Has the project scope been modified? Yes No

If so, how and why, and what is the impact to the project?

Due to the challenges experienced early in the project and extra time spent resolving them, the funding of the project was not sufficient to hit all planned milestones. As such, it might appear that the scope of the project was narrowed. However, since the project continues as a CINT user project, we intend to reach all planned milestones of the original project by the end of the calendar year.

7. Has the customer been notified of any scope change? Yes No

8. Optional: attach any photos or data or other information you feel is useful.