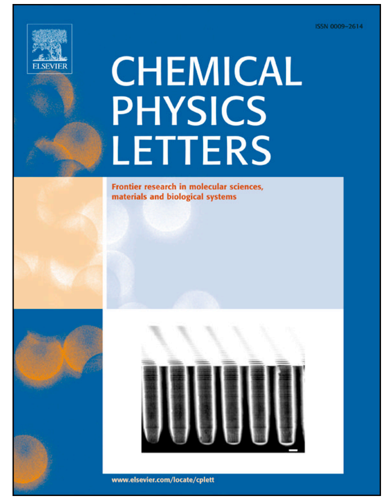
Accepted Manuscript



Research paper

A Concise and Antioxidative Method to Prepare Copper Conductive Inks in a Two-Phase Water/Xylene System for Printed Electronics

Yunzi Liu, Wei Zhang, Helong Yu, Zhiyuan Jing, Zhanyong Song, Sijie Wang

PII: S0009-2614(18)30602-X
DOI: https://doi.org/10.1016/j.cplett.2018.07.057
Reference: CPLETT 35821

To appear in: *Chemical Physics Letters*

Received Date: 14 June 2018
Revised Date: 19 July 2018
Accepted Date: 25 July 2018

Please cite this article as: Y. Liu, W. Zhang, H. Yu, Z. Jing, Z. Song, S. Wang, A Concise and Antioxidative Method to Prepare Copper Conductive Inks in a Two-Phase Water/Xylene System for Printed Electronics, *Chemical Physics Letters* (2018), doi: https://doi.org/10.1016/j.cplett.2018.07.057

A Concise and Antioxidative Method to Prepare Copper Conductive Inks in a Two-Phase Water/Xylene System for Printed Electronics

Yunzi Liu, [a] Wei Zhang, [bc] Helong Yu,[a] Zhiyuan Jing,[a] Zhanyong Song[a] and Sijie Wang[*d]

[a.] *National Key Laboratory for Remanufacturing, Army Academy of Armored Force, Beijing 100072, China.*
[b.] *Beijing Ruiman technologies Co. Ltd, Beijing 100043, China*
[c.] *Hebei Jingjinji Institute of Remanufacturing Industry & Technology, Hejian, Hebei 062405, China*
[d.] *National Engineering Research Centre for Mechanical Product Remanufacturing, Army Academy of Armored Force, Beijing 100072, China. E-mail: wsj665588@126.com*

This paper introduces a method to prepare copper nanoparticles in a two-phase water/xylene system, to be used in the fabrication of ink with high conductivity for printed electronics. Copper conductive inks were obtained simply by extracting the xylene layer containing copper nanoparticles from the reaction system. The particles are monodisperse and range in size from 8 to 29 nm and have no direct contact with air, from nucleation to the preparation of inks. Conductive films prepared using the inks have relatively low resistivity after sintering, which enables their application in electronic devices.

Keywords: Conductive inks; Printed electronics; Copper nanoparticles; Two-phase system

1. Introduction

Conductive inks, which are a type of colloid formed by dispersion of the conductive phase in a solvent, may be printed directly on substrates to form conductive circuits or electronic devices. As the key element of printed circuit technology, conductive inks have received significant attention in recent years.[1–3] Compared with traditional electronic manufacturing technology, electronic devices manufactured using printing techniques possess numerous unique advantages, such as being environmentally friendly, energy efficient, inexpensive, flexible, and non-contact.[4,5] Owing to these merits, conductive inks exhibit an enormous potential for application in solar cells, thin film transistors, radio frequency identification tags, transparent electrodes, and flexible electronic devices.[6–11]

Nano-silver conductive inks are the most widely applied conductive inks in the industry owing to their mature synthesis techniques and excellent performance.[12] However, their popularization and mass production are limited because of their high cost. Thus, lower-cost copper conductive inks with high conductivity have been developed as an appropriate substitute: Park *et al.*[13] synthesized Cu nanoparticles (NPs) with a size of 40–50 nm via a polyol process. Well-dispersed conductive ink with low viscosity was prepared from Cu NPs. The printed patterns exhibited a metal-like appearance and became highly conductive upon heating; the resistivity of the film reached 17.2 μΩ·cm. In other work, Ida *et al.*[14] reported the preparation of Cu NPs coated with a gelatin layer, with an average particle diameter of 46 nm. Conductive films fabricated from a Cu NP ink were annealed at 200 ℃ under 10 ppm O_2–N_2 mixed gas flow and reductive calcination at 250 °C under 3 vol.% H_2–N_2 mixed gas flow. After annealing, the Cu films exhibited a low resistivity of 5 μΩ·cm. Kubota *et al*.[15] reported the synthesis of Cu NPs using a continuous supercritical hydrothermal synthesis method. The synthesized surface-modified Cu NPs were 18 nm in size and spherical in shape. Conductive films prepared from the Cu NPs had a resistivity of 16 μΩ·cm.

These studies reported the production of copper conductive inks with good performance; however, as Cu NPs rapidly oxidize in air, complex technology and sophisticated equipment was required to avoid exposing the particles to oxygen during the ink fabrication processes