Workshop « Soft Material Models »
Les 01 et 02 juin 2023 à l'Ecole Centrale Casablanca, Maroc

Enhancing the Electrical Conductivity of Copper Phthalocyanine Ink for Screen-Printing on Textiles: An Optimization Study

A, Batine [a,b,*], A. Boumeganane [a, b], A. Nadi[b], O. Cherkaoui [b], M. Tahiri [a]

[a] Organic Synthesis, Extraction and Valorisation Laboratory (SOEV) Ain Chock 's Sciences Faculty, Hassan II University of Casablanca; Km 7 Route d'El Jadida, 20230. Casablanca, Morocco.

[b]Laboratory of Research on Textile Materials (REMTEX), Higher School of Textile and Clothing Industries (ESITH), Km 8 Route d'El Jadida, 20230 Casablanca, Morocco.

Abstract

Our research focused on examining the conductivity of conductive ink containing copper phthalocyanine (CuPc). To accomplish this, we utilized different organic solvents, namely dimethylsulfoxide and Tetrahydrofuran, while also adjusting the concentration of CuPc. By combining CuPc pigment with a screen-printing paste, we could generate a variety of designs on a cotton surface with customizable CuPc levels. To assess the impact of solvents on CuPc dispersion, we employed UV visible spectroscopy. Our findings revealed that the printed circuit board demonstrated the least resistance when the CuPc concentration was approximately 3% in both THF and DMSO solvents. The resistance measurements were roughly 1 MΩ/cm and 1.8 MΩ/cm, respectively.

Methodology

For the preparation of screen-printing ink based on copper phthalocyanine, different masses of CuPc were dispersed in THF and DMSO. The ultrasonic assisted dispersion process was used for the dispersion of CuPc. The following table shows copper phtalocyanine based conductive ink formulations.

Table : Copper Phthalocyanine Based Conductive Ink Formulations

Ink label	DMSO (ml)	Printing Paste (g)	CuPc (g)
I_1	10	30	0,25
I_2	-	-	0,75
I_3	-	-	1,25
I_4	-	-	1,75
I_5	-	-	2,5
Ink label	**THF (ml)**	**Printing Paste (g)**	**CuPc (g)**
$I_{1'}$	10	30	0,25
$I_{2'}$	-	-	0,75
$I_{3'}$	-	-	1,25
$I_{4'}$	-	-	1,75
$I_{5'}$	-	-	2,5

Context

With the increasing interest in integrating electronic functionality into fabrics, conductive inks have gained attention as a viable solution. CuPc ink, known for its conductivity, shows potential for this application. However, achieving optimal conductivity requires careful formulation and optimization. The study aims to identify the ideal combination of ink composition, solvent selection, and CuPc concentration through systematic investigation. The findings will contribute to advancements in textile electronics and the development of functional smart textiles.

Results

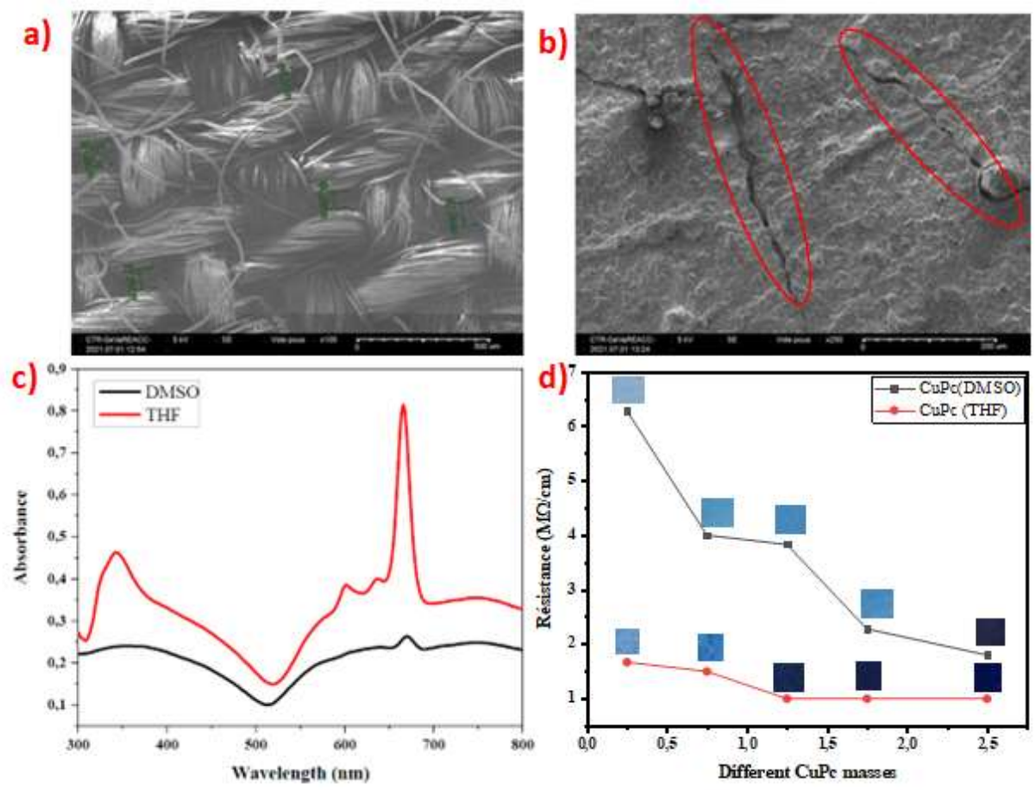

Figure: SEM images of untreated cotton (a), and cotton printed with CuPc-based paste (b), UV-visible spectrum of CuPc(c), Electrical resistance curves of samples printed with CuPc paste dispersed in DMSO, CuPc paste dispersed in THF

SEM analysis revealed that raw cotton **(figure a)** had a porous structure with intertwined fibers, while the textile printed with CuPc-based paste **(figure b)** had agglomerations and cracks, reducing electrical conductivity.[1] **Figure c** shows that CuPc dispersed in THF exhibits a narrower, more intense peak at 340 nm in the UV-visible spectrum, indicating improved orbital transition compared to DMSO dispersion. THF was preferred for CuPc dispersion due to peaks at 590 nm and 660 nm.[2][3] **Figure d** shows that the increasing of CuPc weight in DMSO decreased resistance and increased conductivity, while in THF, resistance decreased until 1.25 g weight, stabilizing at 1 MΩ/cm due to random dispersion's impact on charge mobility.[3]

Conclusion and perspectives

This study involved creating conductive inks using copper phthalocyanine. The inks were made by dispersing CuPc in two different solvents. The inks dispersed in THF showed superior dispersion compared to those dispersed in DMSO. The electrical resistance decreased as the amount of CuPc increased. These findings suggest that the conductive copper phthalocyanine ink dispersed in THF and applied through screen printing can be more effectively used on textiles due to THF's lower boiling temperature.

References

[1] Aruchamy, K., Subramani, S. P., Palaniappan, S. K., Sethuraman, B., & Kaliyannan, G. V. (2020). Study on mechanical characteristics of woven cotton/bamboo hybrid reinforced composite laminates. *Journal of Materials Research and Technology*, *9*(1), 718-726.

[2] Salehabadi A, N Morad, MI Ahmad (2020) A study on electrochemical hydrogen storage performance of β-copper phthalocyanine rectangular nanocuboids. *Renewable Energy* 146: 497-503.

[3] Boumegnane, A., Nadi, A., Cochrane, C., Boussu, F., Cherkaoui, O., & Tahiri, M. (2022). Formulation of conductive inks printable on textiles for electronic applications: a review. *Textile Progress*, *54*(2), 103-200.

[4] Malik A, Magisetty RP, Kumar V, Shukla A, Kandasubramanian B (2020) Dielectric and conductivity investigation of polycarbonate-copper phthalocyanine electrospun nonwoven fibres for electrical and electronic application. *PolymerPlastics Technology and Materials* 59: 154-168.