IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO - IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

METHOD FOR GENERATING DIFFERENT PHASES OF COPPER SULPHIDE NANOSTRUCTURES USING ELECTROSPRAY DEPOSITION (ESD) UNDER AMBIENT CONDITIONS

IITM Technology Available for Licensing

Problem Statement

- Currently Chemical Vapor Deposition (CVD) is the most common synthetic method, extensively used for making high quality atomic layer thin films of copper sulphide for different applications, where **high temperature processing is required for making such materials for electronic applications**
- Hence, there is a long felt need for synthesising specific **copper sulphide nanostructures under ambient conditions for practically viable applications**

Technology Category/ Market

Category – Advance Material and Manufacturing
Applications –Drug delivery systems, batteries, semiconductors , photocatalysis, sensors,
Industry - Biomedical, Electrical
Market -The global **nanomaterials market size** was valued at **USD 11.43 billion in 2022** and it is expected to hit **USD 43.1 billion by 2030**, registering growth at a **CAGR of 18.05% from 2022 to 2030.**

Key Features / Value Proposition

Technical perspective

- Generates different phases of copper sulphide nanostructures -**Chalcocite** (Cu_2S) nanopyramids are formed by superionic diffusion of sulphur into copper, **digenite**($Cu_{1.8}S$) platelets are formed by slow ionic diffusion of sulphur ions through lattice vacancies in Cu_2S nanopyramid
- Cu_2S exhibits **positive photocurrent response** under electrochemical conditions
- $Cu_{1.8}S$ **platelets** exhibit **sharp metallic conductance** due to accumulation of free charge carriers

User perspective

- Efficient method to synthesize specific copper sulphide nanostructures under **ambient conditions**
- **Does not require solvent and harsh synthetic conditions**

Technology

- The present invention discloses a method of **generating different phases of copper sulphide nanostructures under ambient temperature using electrospray deposition (ESD). The said method comprising:**

1. **spraying sulphur in the form of droplets on a metallic copper surface for 2 to 5 min**
2. **generating nanopyramids of 1 to 2 mm edge length**
3. **subsequent spraying of sulphur over the nanopyramids for more than 5 mins**
4. **generating platelets on top of the nanopyramids**

Image

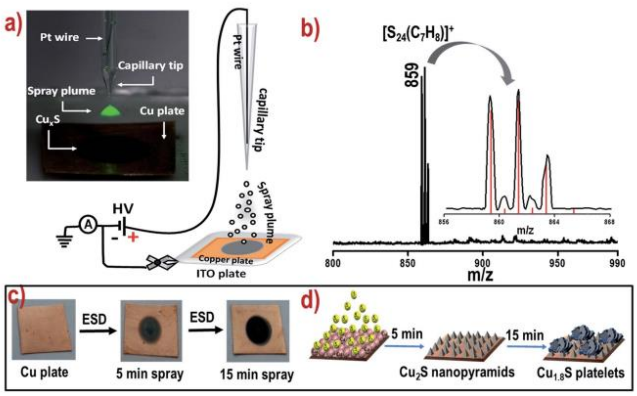

Fig. 1 (a) Schematic representation of the ESD set-up (inset shows the optical image of the 25 spray plume), (b) ESI-MS spectrum of sulphur solution (inset spectrum in black shows the experimental spectrum and red lines show the theoretical spectrum), (c) time-dependent evolution of a black circular spot during ESD, and (d) schematic representation of the growth mechanism of chalcocite **(Cu_2S) nanopyramids and digenite ($Cu_{1.8}S$) platelets during ESD.**

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Images

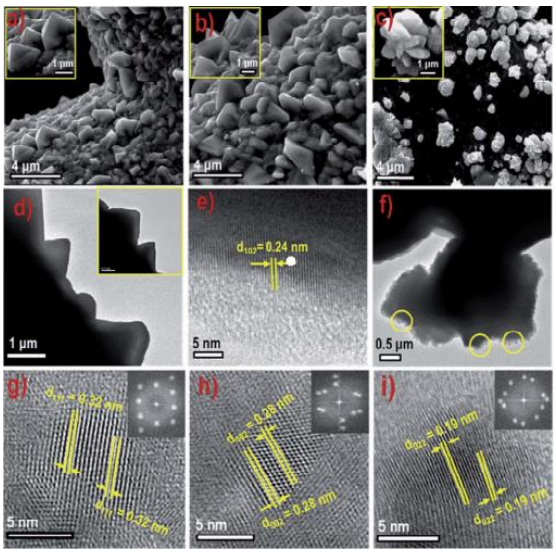

Fig. 2 (a–c) Large area SEM images at different times of deposition: (a) 2 min spray, (b) 30 min spray, and (c) 15 min spray (inset shows a higher magnification SEM image), (d) low magnification **TEM image of Cu_2S nanopyramids** (inset depicts the higher magnification TEM image), (e) **HRTEM of Cu_2S nanopyramids**, (f) **TEM image of $Cu_{1.8}S$ platelets**, and (g–i) **HRTEM image of $Cu_{1.8}S$ platelets**. Lattice parameters are marked and inset images show the corresponding FFT patterns

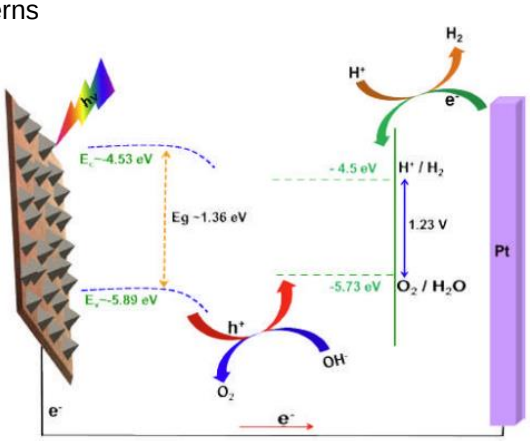

Fig. 3 Schematic representation of the photoelectrochemical process at **Cu_2S nanopyramids**

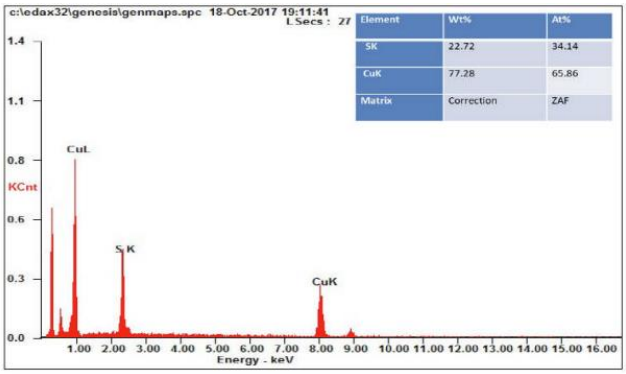

Fig. 4 EDAX spectrum of the **Cu_2S** nanopyramids (inset shows the elemental distribution of the **Cu_2S** nanopyramids)

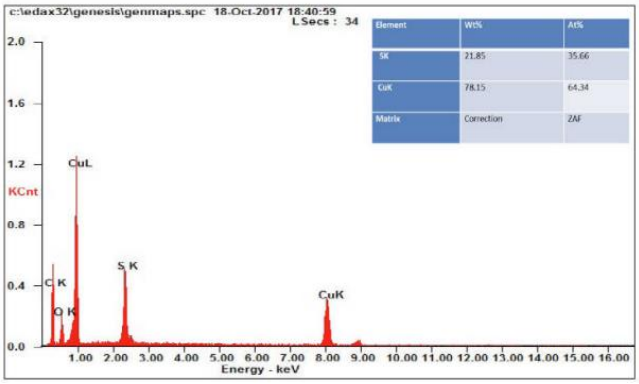

Fig. 5 EDAX spectrum of the **$Cu_{1.8}S$** platelets (inset shows the elemental distribution for the Cu1.8S platelets).

Intellectual Property

- **IITM IDF Ref. 1895**
- **IN 396273-Granted**

TRL (Technology Readiness Level)

TRL-3, **Experimental proof of concept**

Research Lab

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