METHOD FOR THE PREPARATION OF BILAYER METAL ELECTROCATALYST FOR CONVERSION OF CO_2 TO FORMIC ACID

IITM Technology Available for Licensing

Problem Statement

- The rise of carbon dioxide levels in the atmosphere may be **controlled by developing processes that convert CO_2 present in industrial flue gases** into value added products such as formic acid.
- Existing electrochemical processes for removal of CO_2 from flue gases **do not take into consideration the presence of other pollutants** such as SOx and NOx that may affect the conversion process.
- There is a need for a catalyst for the **electrolytic conversion of CO_2 to formic acid** even in the presence of impurities such as SOx and NOx

Intellectual Property

- IITM IDF Ref.**2493**
- **IN 535946 Patent Granted**

TRL (Technology Readiness Level)

TRL 5 Technology Validated in Relevant Environment

Technology Category/ Market

Category- Green Technology

Industry Classification:

- **NIC (2008)- 2592-** Machining; treatment and coating of metals**; 28195-** Manufacture of filtering and purifying machinery or apparatus for liquids and gases ; **35102**- Electric power generation by coal based thermal power plants; **20119** Manufacture of organic and inorganic chemical compounds

Applications:

Carbon Capture; formic acid can be used for leather tanning, animal feed preservative, cleaning agents etc.

Market Drivers:

The global Carbon Capture, Utilization, and Storage market size is projected to grow from USD 3.1 Billion in 2022 to USD 12.9 Billion by 2030 with a CAGR of 24 %

Research Lab

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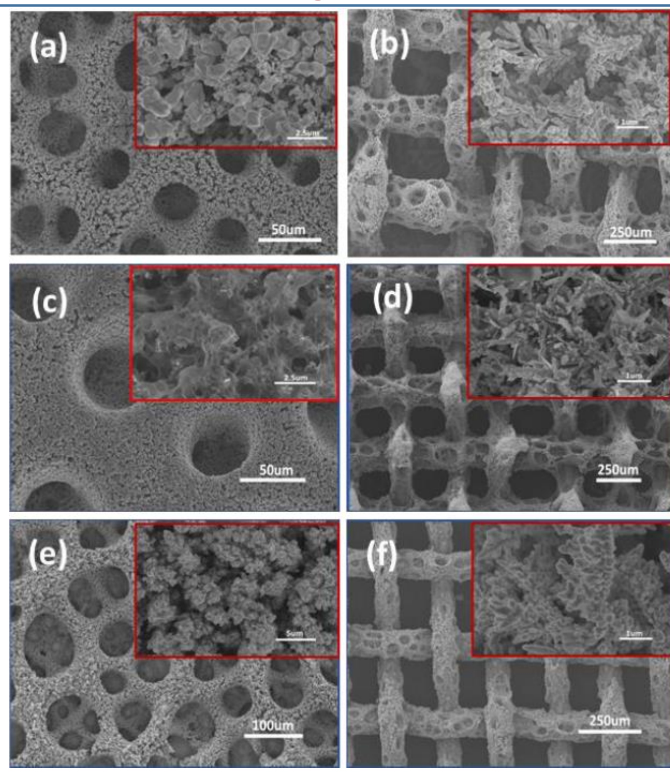

Figure: SEM micrographs of catalyst particles deposited on Cu foil and Cu mesh substrates**. (a)** Sn coated on Cu foil-foam; **(b)** Sn coated on Cu mesh-foam; **(c)** Bi coated on Cu foil-foam**; (d)** Bi coated on Cu mesh-foam; **(e)** In coated on Cu foil-foam; and **(f)** In coated on Cu mesh-foam;

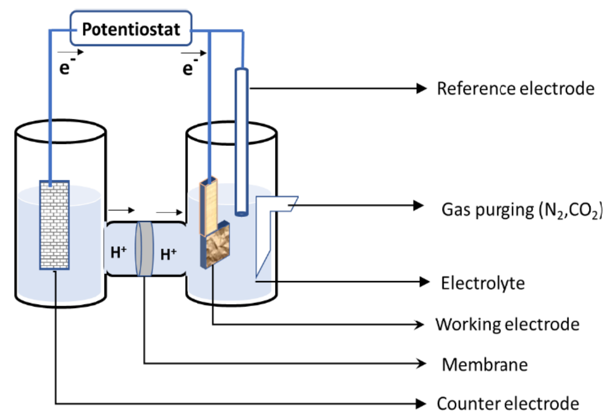

Figure: H-type electrochemical experimental setup employed to test the CO_2 reduction activity.

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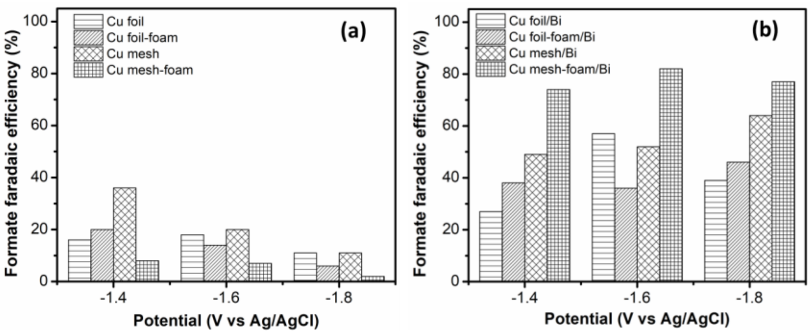

Figure: Cu based electrocatalysts show formate Faradaic Efficiency (FE) ranging from 2% to 36%, Bi coated electrocatalysts show formate FE ranging from 30% to 85%,

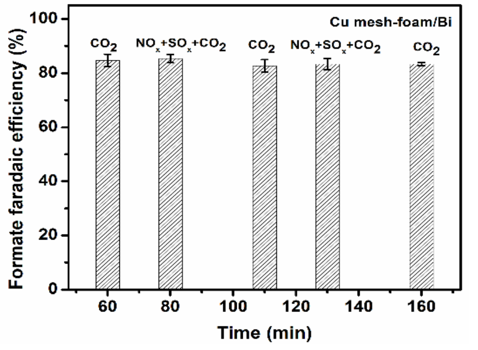

Figure: The faradaic efficiency following the exposure of electrocatalyst (Bi coated Cu mesh-foam) to combinations of SOx and NOx remained stable, indicating that there was no deterioration in the performance of the catalyst.

Technology

- **Electrolytic conversion of CO_2 present in industrial flue gas to formic acid using a bilayer metal electrocatalyst comprising a metal selected from tin (Sn), bismuth (Bi), and indium (In), coated on a three-dimensional (3D) porous electrode material made of conducting Cu film-foam or Cu mesh-foam structure.**
- **Porous Cu foam structure on a mesh substrate provides high electrochemical active surface area to enhance the reduction activity. Additionally, the deposition of Sn or Bi catalyst particles on the Cu foam surface helps to tune selectivity towards formate by specifically adsorbing HCOO−intermediate.**
- **When flue gas is passed over the synthesized electrocatalyst, CO_2 conversion to formic acid is not affected by the presence of impurities such as SOx and NOx which are typically present in industrial flue gas. The electrocatalysts with high selectivity to formic acid were also tested with varying CO_2 concentrations ranging from 15% to 100%.**
- **H-type electrochemical setup used for constant potential CO_2 electrolysis and voltammetry studies. The experiments were carried out using the setup with a three-electrode configuration and electrochemical workstation operated at room temperature and ambient pressure. Linear sweep voltammetry (LSV) is the primary technique used to test the activity of the catalysts towards CO_2 reduction ability by measuring onset potential and current density.**

Key Features / Value Proposition

- The electrochemical reduction of CO_2 into chemical fuels is a promising approach due to high energy efficiency, and the products, especially chemical fuels, can be easily stored when compared to other methods.
- Electro-catalyst (Bi coated Cu mesh-foam) demonstrated an excellent stable formic acid faradaic efficiency of 80±5% with a high current density of −12 mA.cm^{-2} over 50 h, and no morphological change to the catalyst surface was observed.
- The bilayer metal electrocatalysts of the present invention, can be used to convert CO_2 present in the flue gas, to formic acid, even in the presence of impurities such as SOx and NOx. Whereas, conventional technologies have not yet been tested in such conditions.

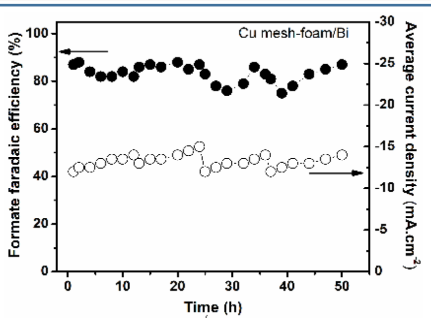

Figure: Results from the CO_2 electrolysis experiment conducted on electrocatalyst (Bi coated Cu mesh-foam) using simulated flue gas mixture containing impurities of SOx (0.08%) and NOx (0.05%), and CO_2.

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