AN ENHANCED CARBON DIOXIDE SORBENT NANOFIBER MEMBRANE AND A DEVICE

IITM Technology Available for Licensing

Problem Statement

- Rapid increase in CO2 concentration in enclosed environments causing health risks and discomfort.
- **Existing CO2 scavenging materials** (e.g., amino silica monolith, MOF-177), require regeneration under extreme conditions, making them **impractical for commercial feasibility**.
- Therefore, there is a need for **a new sorbent material that can efficiently adsorb CO2 at room temperature and desorb it** at near ambient conditions providing a cost-effective and energy-efficient solution for maintaining CO2 concentration within acceptable limits in closed spaces.
- The objective of this invention is to **develop a composite fiber material with excellent CO2 adsorption and desorption properties,** enabling the creation of a compact and sustainable device (refer Fig.1) for CO2 removal, ensuring healthy and comfortable living environments.

Technology Category/ Market

Category - Air Purification & Filteration, Chemistry & Chemical Analysis.
Applications - Nanofibers, Air Purification & Filteration, CO2 Capture and Sequestration, Indoor Air Quality Improvement, Climate Control Systems
Industry - Environmental Technology, Clean Energy, Indoor Air Quality,

Market - The nanofiber market is projected to reach USD 4.16 billion by 2030, at a **CAGR of 12.0%** from USD 1.68 million in 2022.

TRL (Technology Readiness Level)

TRL - 4, Technology validated in lab.

Research Lab

Prof. Pradeep .T, Dept. of Chemistry

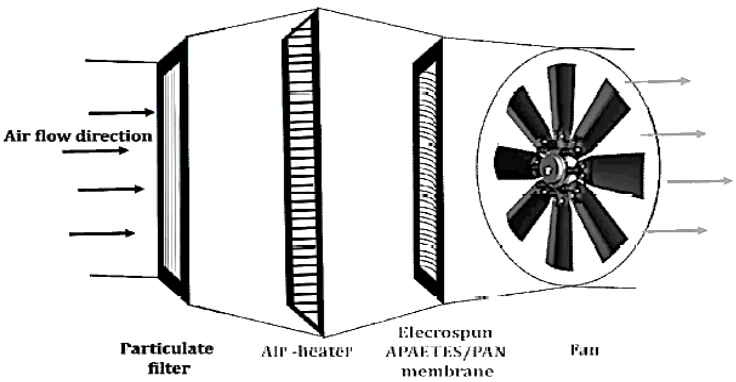

FIG.1. Depicts the schematic diagram of proposed device.

Intellectual Property

- IITM IDF Ref. **1641**
- **IN 4343314 - Patent Granted**
- **PCT/IN2019/050555 - Published**

Technology

1. **Invention:** Material for air purification, adsorbs CO2 at room temperature and desorbs at near ambient temperature
2. **Fabrication:** Nanofiber membrane by electrospinning AEAPTMS/PAN composite with large surface area. (refer Fig. 2)
3. **CO2 Adsorption Capacity:** ≥ 0.77 mmol/g at 24°C, fully regenerates at 45°C.
4. **Adsorption Cycle**: 120 minutes.
   Desorption Cycle: 30 minutes.
5. **Mechanism:** FTIR analysis confirms the formation confirms ammonium bicarbonate and ammonium carbamate for CO2 adsorption at room temperature, desorbs by decomposing compounds at 55°C, preferably 50°C or lower.
6. **Air Purification Integration:** Used in device with air purifier, air conditioner, and heater, 40 minutes adsorption and 20 minutes desorption (or 20 minutes adsorption and 10 minutes desorption) and Fig. 4 shows the rate of desorption at different ambient temperature.

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Key Features / Value Proposition

1. The composite material N-[3-(Trimethoxysilyl) propyl]ethylenediamine (AEAPTMS) functionalized polyacrylonitrile (PAN/AEAPTMS) shows a **CO2 adsorption capacity of 0.77 mmol/g** at an ambient condition of 70% relative humidity, 24°C temperature, and **3400 ppm CO2 concentration**.
2. The nanofiber material exhibits **100% cycling capacity over three adsorption-desorption cycles**. It shows an average of 0.347 mmol/g CO2 adsorption capacity for the initial 30 minutes of the adsorption cycle and 100% desorption capacity when heated to 50°C. (refer Fig. 3, 5)
3. **Optimal Nanofiber Diameter -** The membrane's nanofiber diameter falls within the range of **1µm to 0.1µm**, which is ideal for efficient CO2 adsorption.
4. **Complete regeneration of adsorbent material at 50°C.**
5. **Fabrication Flexibility:** The nanofiber membrane can be fabricated using different techniques like **melt spinning, melt electrospinning, or electrospinning**.

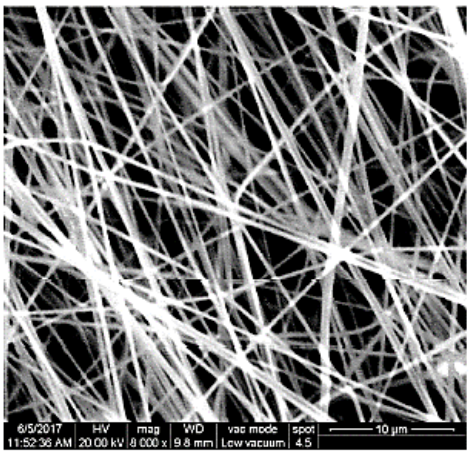

FIG. 2. SEM image of AEAPTMS/PAN composite electrospun material.

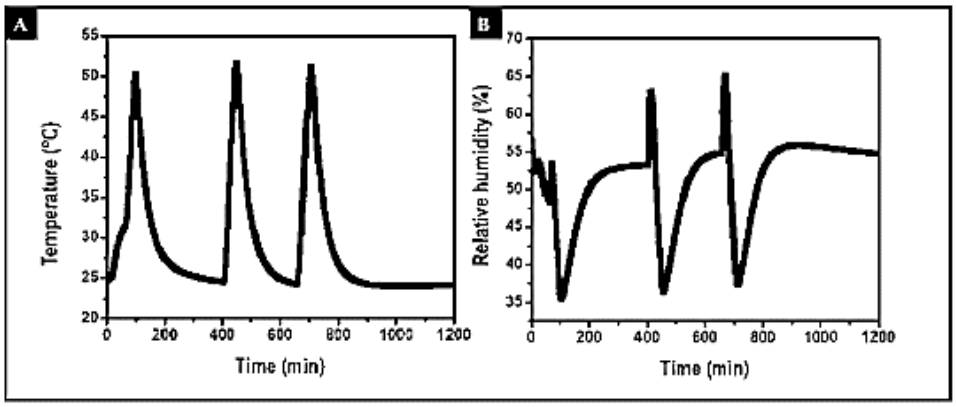

FIG. 3. Depicts ambient temperature and relative humidity during CO2 desorption by electrospun AEAPTMS/PAN (composite-1).

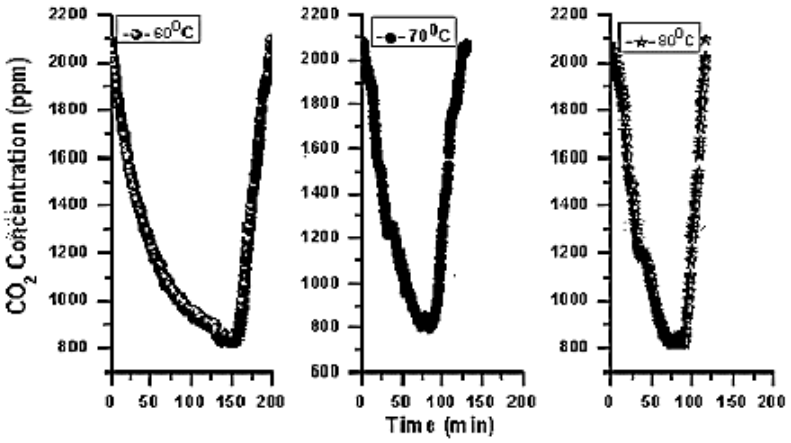

FIG. 4. Depicts the rate of desorption at different ambient temperature for AEAPTMS/PAN (composite-1).

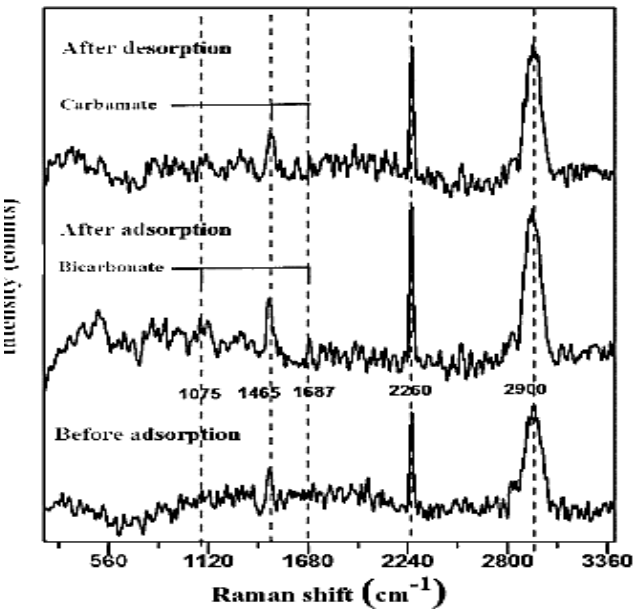

FIG. 5. Depicts the Raman spectrum of electrospun AEAPTMS/PAN (composite-1) before adsorption, after CO2 adsorption and after CO2 desorption.

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