GRAPHENE-POLYVINYL ALCOHOL COMPOSITE FILM AND PREPARATIONS THEREOF

IITM Technology Available for Licensing

Problem Statement

- Numerous **optical filters are available for controlling light**, mainly absorptive and reflective type.
- The disadvantage with a **reflective filter** is that it creates a **multiple reflections** in the work environment. These **reflections are harmful** to the eyes and human body.
- The **conventional absorption filters** are made with dyes, pigments and glass dopants. These cannot be used in the high power lasers due to **local heating effects**.
- The **nearly zero band gap nature of graphene** results in broadband absorption in the electromagnetic spectrum. A single layer of graphene **can absorb 2.3% incident white light** and proportionally to the number of layers.
- There is a need to **develop easy to prepare graphene-based optical filters** with broad band absorption, high thermal stability, superior mechanical properties while being cost effective.

Intellectual Property

- IITM IDF Ref 1290
- **IN 337591 Patent Granted**

TRL (Technology Readiness Level)

TRL 4 Technology Validated in Lab

Technology Category/ Market

Category-Micro & Nano Technologies

Industry Classification:

- **NIC (2008)- 32507-** Manufacture of ophthalmic goods, eyeglasses, sunglasses, lenses ground to prescription, contact lenses, safety goggles etc ; **20297** Manufacture of chemical products or preparations of a kind used in textiles etc.

Applications:

Sunglasses, Optical filers for scientific industry and research , Coating windows for transport vehicles and houses, Textiles industry.

Market report:

The Global UV filter market is projected to grow from USD 334.71 million in 2023 to USD 482.24 million by 2030, exhibiting a CAGR of 5.4% during the forecast period.

Research Lab

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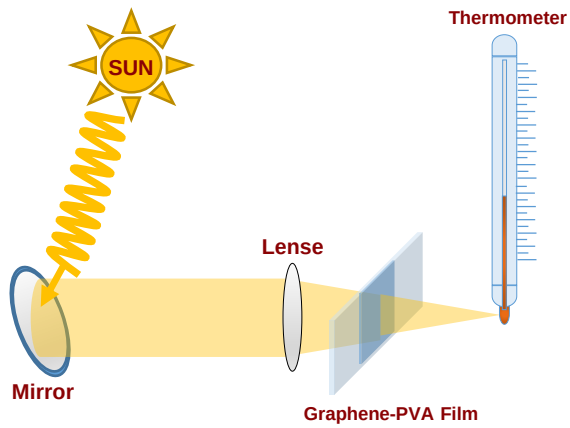

Figure: Experimental setup for measuring the temperature of solar radiation.

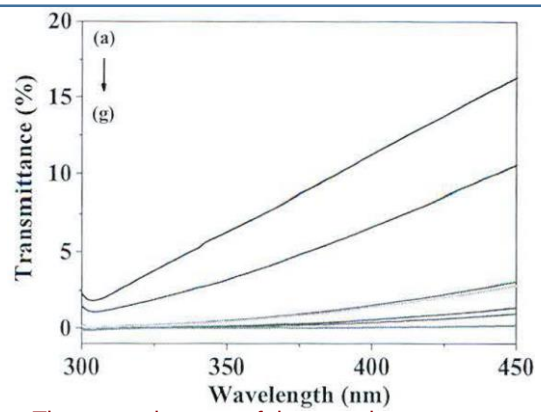

Figure: The transmittances of the samples were measured using UV-Visible-NIR dual beam spectrometer (JASCO-V-570). Based on the film thickness or amount of graphene presented in the polymer, the film controls up to achieves nearly 0% transmittance of the UV light

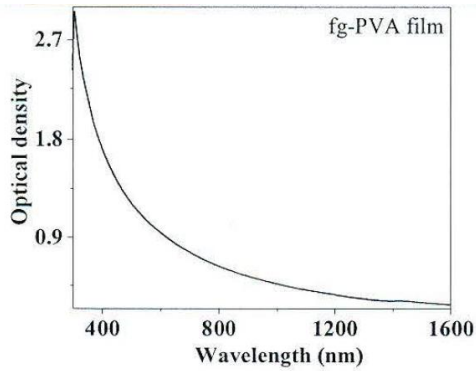

Figure: The absorption spectra were recorded using the UV-visible dual beam spectrometer (JASCO, V-570). Graphene-PVA film shows broad band absorption over a UV to IR region

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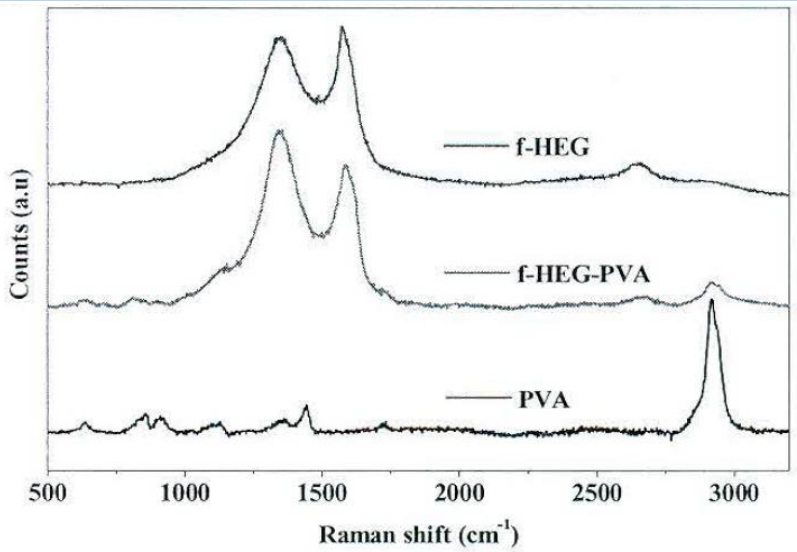

Figure: Raman spectra of the PVA film, Functionalized Hydrogen induced exfoliated graphene (f-HEG) powder and f-HEG- PVA film. Raman spectra of the films and raw materials were recorded with a Jobin Yvon model HR-800 equipped with a He-Ne laser (632.8 nm). Raman measurements were done for checking the characteristics of graphene embedded PVA polymer.

Technology

Graphene oxide is produced by a modified Hummer's method and exfoliated in the presence of hydrogen gas at 200°C; finally the graphene is functionalized using acid to obtain Functionalized Hydrogen induced exfoliated graphene (f-HEG). The obtained f-HEG in solution is degassed and sonicated to limit the particle size to 3 µm

Polyvinyl alcohol (PVA) is dissolved in a polar solvent, wherein the polyvinyl alcohol wt% in the polar solvent is in the range of 10 to 30 % w/v

Polyvinyl alcohol solution with said solution of functionalized graphene are contacted in a volume ratio range of 3: 1, 1: 1 and 5:3 ratio to obtain a mixture.

The mixture or the degassed mixture of polyvinyl alcohol solution and the solution of functionalized graphene can be coated on a substrate by conventional methods such as spin coating to form a uniform layer. The substrate can be any uniform material such as a film, sheet, wafer or, a large three-dimensional object.

The coated substrate is dried to obtain a graphene-polyvinyl alcohol composite film with thickness in the range of 15-35 µm to 120µm. The film once dried can be removed to obtain a free standing film.

The graphene-polyvinyl alcohol film can be attached to the surface as such or with the help of adhesives. The graphene-polyvinyl alcohol composite film has % transmittance in the range of 0-20 for light in range of 300 nm to 450 nm

Key Features / Value Proposition

- The graphene-polyvinyl alcohol composite film can be used for optical cooling. the graphene-polyvinyl alcohol composite film achieves nearly 0% transmittance of the UV light. The broad band absorption and high thermal conductivity of the graphene-polyvinyl alcohol composite film helps to extract the heat from the solar radiation.
- The invented process uses simple process with non-toxic solvents for dissolving the PVA. Whereas, conventional Chemical Vapor Deposition (CVD) techniques have complex growth process and transformation while requiring use of toxic solvents
- Compared to the other methods like chemical vapor deposition and mechanical exfoliation, the method disclosed in the present disclosure is economical and large scale productions of the graphene-PVA films are possible for industrial applications.
- The graphene-polyvinyl alcohol composite film can be fabricated on the silica glass substrate and optical filter made from such films sustain high fluence of light without degradation of the components of the film.
- The filters including graphene-polyvinyl alcohol composite film can withstand light of picosecond (at 355 nm and 532 nm), and CW lasers for a few hours. Whereas, conventional optical filters consist of dyes that may get degraded due to local heating effects.

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