VSB TECHNICAL UNIVERSITY OF OSTRAVA | CENTRE FOR ENERGY AND ENVIRONMENTAL TECHNOLOGIES | NANOTECHNOLOGY CENTRE

Fibrous PVDF membranes modified by anchored g-C_3N_4@GO composite with enhanced photocatalytic activity

Z. Vilamová[1], P. Czernek[1,2*], J. Zagora[1,2], L. Svoboda[1], J. Bednář[1], Z. Šimonová[3], D. Plachá[1], R. Dvorský[3]

[1] CNT, CEET, VSB – Technical University of Ostrava, Czech Republic
[2] FMT, VSB – Technical University of Ostrava, Czech Republic
[3] CPIT, FMT, VSB – Technical University of Ostrava, Czech Republic
***pavel.czernek1@vsb.cz**

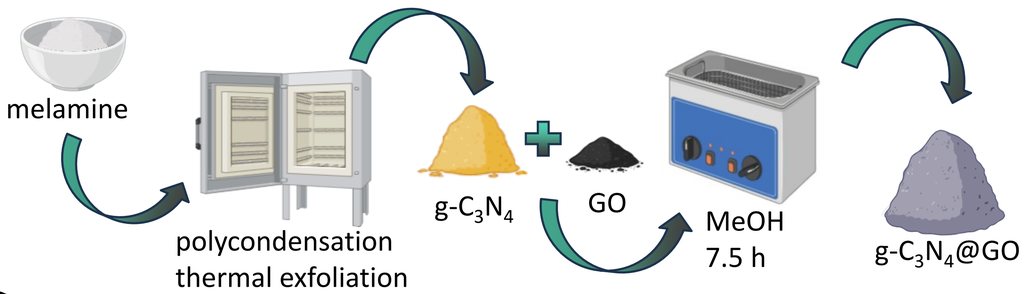
MOTIVATION

Recently, the development of fibrous membranes for pollutant filtration from air or water has been a topic of great interest. However, these filters' high and rapid fouling has limited their use. In response, we have prepared photocatalytic active membranes that harness the synergic effect between graphene oxide (GO) and graphitic carbon nitride (g-C_3N_4). The resulting composite demonstrated the highest photocatalytic activity (k_{obs} = 88 × 10^{-3} min^{-1}). This g-C_3N_4@GO composite was then carefully deposited on/in an electrospun polyvinyl difluoride (PVDF) fibrous membrane. The reproducible results of the chemical bonding of the composite to the PVDF matrix were evident during photocatalytic experiments after ten Rhodamine B (Rh B) photocatalytic degradation cycles. Importantly, the fiber structure analysis post-reaction did not reveal any fiber cracks or void formation defects, indicating the excellent chemical stability of the PVDF fibrous matrix. This research offers a promising, sustainable, eco-friendly, and efficient solution for removing pollutants from different environments, inspiring further exploration and development in this field.

EXPERIMENTS AND RESULTS

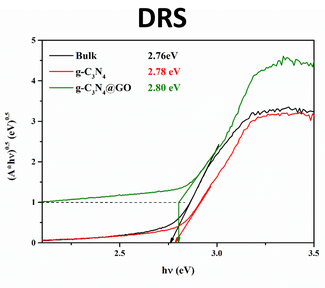
COMPOSITE

PREPARATION



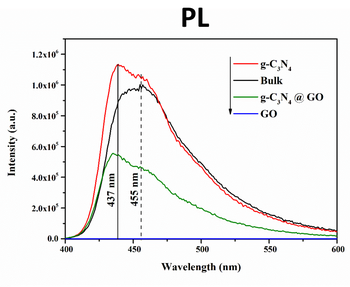
CHARACTERIZATION

DRS



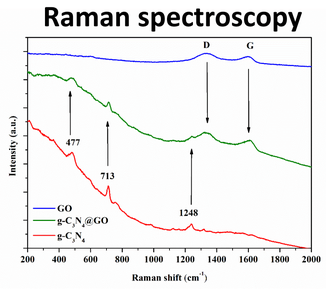
- **Tauc plot** for band gaps energies
- **Increase** of **light absorption** properties

PL



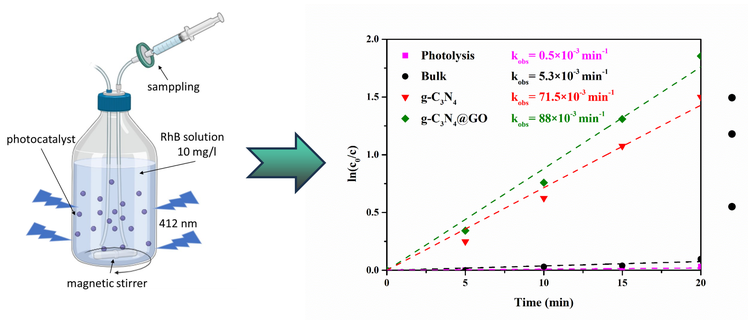
- Indication of **e^- and h^+ recombination**
- **Lower** PL intensity of composite caused by **single-layered GO**

Raman spectroscopy



- **Presence** of **GO**
- Specific disorder **(D)** and graphitic **(G)** bands
- A morphous material -> I_D/I_G

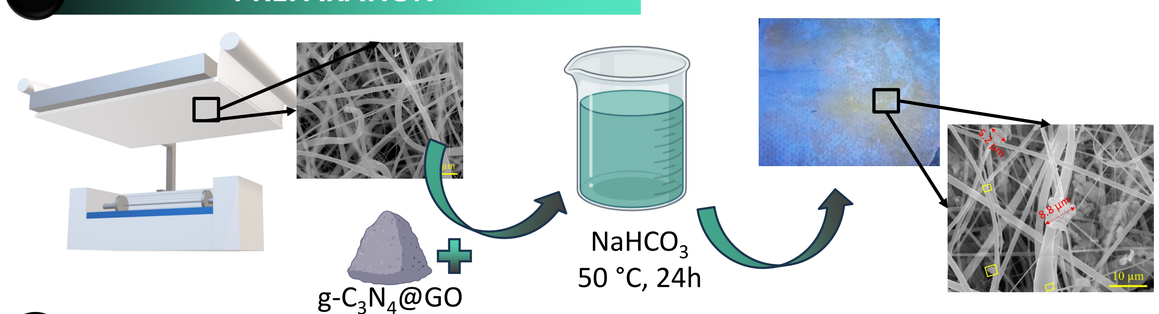
PHOTOCATALYTIC PROPERTIES



- **RhB degradation**
- g-C_3N_4@GO showed the **highest constant**
- g-C_3N_4@GO further used for deposition

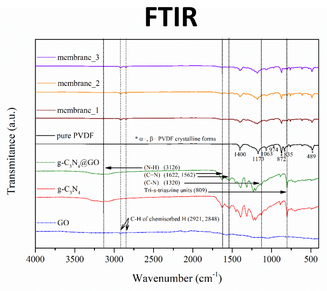
MEMBRANE

PREPARATION



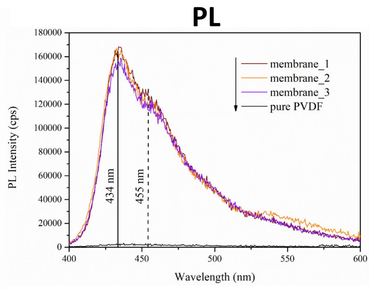
CHARACTERIZATION

FTIR



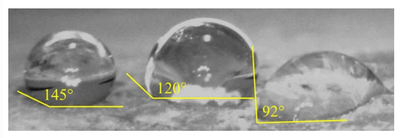
- **No structural changes** of PVDF polymer
- Absorption bands typical for g-C_3N_4 and GO

PL



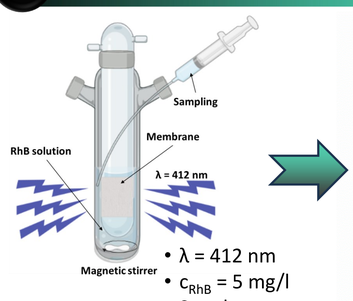
- **Deposited** g-C_3N_4@GO **particles** confirmed by two PL peaks located around 434 and 455 nm

Drop analysis

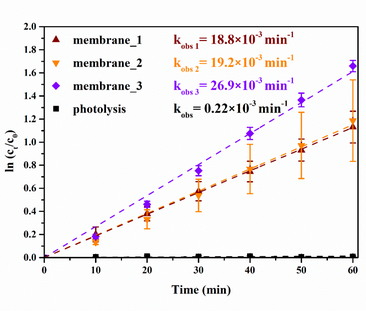


- **Hydrofobity** of pure PVDF
- **Hydrofility increased** after composite deposition

PHOTOCATALYTIC PROPERTIES



- λ = 412 nm
- c_{RhB} = 5 mg/l
- 3 cycles



- **RhB degradation**
- **Reproducible results** of chemical deposition
- Fiber **stability**

CONCLUSION

The prepared composite g-C_3N_4@GO showed the highest photocatalytic activity (k_{obs} = 88 × 10^{-3} min^{-1}) compared to unmodified g-C_3N_4 samples. This was attributed to a synergic effect between g-C_3N_4 and GO was achieved. This final composite was further used for chemical bonding to PVDF membranes by chemical reaction in the presence of carbonate-bicarbonate.

Three photocatalytic membranes were prepared under the same conditions. All membranes were analyzed using several analytical methods and further tested for photocatalytic RhB degradation with reproducible results. The chemical bonding of composite g-C_3N_4@GO to the PVDF fibrous matrix was successful since no washout of the composite was observed after photocatalytic reactions. Moreover, after three cyclic photocatalytic experiments, it was found that there was no decrease in photocatalytic activity. The future focus of this research will be to overcome inhomogeneity in particle deposition on the fiber surfaces, which should lead to even greater photocatalytic activity of these membranes.

ACKNOWLEDGEMENTS

REFRESH PolyEnvi21 SAFER MATUR