A.1: (Adsorption Kinetics calculations)

To determine the k_1 and k_2

Here, m_2 i.e. (amount of oil adsorbed nanoparticles) = 0.2277g.

m_1 i.e. (amount of pristine nanoparticles) = 0.0510 g.

t=1 sec (i.e. magnetic removal response time)

Applying equation (1) given in main manuscript,

$$\log(m_2 - m_1) = \log m_2 - \frac{k_1}{2.303} t \quad \text{---------- (1)}$$

$$=> \log(0.2277 - 0.0510) = \log 0.2277 - \frac{k_1}{2.303} * 1$$

$$=> \log(0.1767) = -0.6426 - \frac{k_1}{2.303}$$

$$=> -0.7527 + 0.6426 = -\frac{k_1}{2.303}$$

$$=> k_1 = 0.1102 * 2.303$$

$$\boldsymbol{k_1 = 0.25}$$

Similar way, we have calculated the value of k_2 following the equation (2) given in main manuscript.

$$\frac{1}{m_1} = \frac{1}{m_2^2 * k_2} + \frac{1}{m_2} \quad \text{---------- (2)}$$

$$=> \frac{1}{0.0510} = \frac{1}{0.0518 * k_2} + \frac{1}{0.2277}$$

$$=> \frac{1}{k_2} = 0.0510\ (19.6078 - 4.3917)$$

$$=> k_2 = \frac{1}{0.7760211}$$

$$\boldsymbol{k_2 = 1.28}$$

The ratio of both the mases from the adsorption kinetics is given as, k_2/k_1 = 1.28/0.25 = 5.12 ≈ **5.** This shows that $k_2 \approx 5k_1$

A.2: Investigating the water vapour transmission rate (WVTR) of 2D heterostructure based film

For calculating the WVTR of the film, the following data were taken:

Initial weight, W_1 = 212.11gm;

Final weight, W_2 = 205.86gm;

$W = W_1 - W_2$ = 6.24 gm.

Area, $A = \pi(\frac{d}{2})^2$ = 3.14 x (1.5 x 1.5) cm² = 0.0007065 m^2

Time, t = 24 hours.

$$WVTR = \frac{\Delta W}{A * t}$$

∴ WVTR=368 gm /m^2 hr

References

[1] Zulfiqar, U., Hussain, S. Z., Subhani, T., and Hussain, I. Mechanically robust superhydrophobic coating from sawdust particles and carbon soot for oil/water separation. *Colloids and Surfaces A*, 539:391-398, 2018.

[2] Li, J., Guan, P., Li, M., Zhang, Y., Cheng, P., and Jia, R. Anticorrosive superhydrophobic polystyrene-coated mesh for continuous oil spill clean-up. *New Journal of Chemistry*, 41:4862-4868, 2017.

****

List of Publications

❖ Papers included in the thesis (UGC care listed)

[1] **Talukdar, M.**, Behera, S.K., Bhattacharya, K., and Deb, P. Surface modified mesoporous g-C_3N_4@ $FeNi_3$ as prompt and proficient magnetic adsorbent for crude oil recovery. *Applied Surface Science,* 473: 275-281, 2018.

[2] **Talukdar, M.**, Behera, S.K., and Deb, P. Graphitic carbon nitride decorated with $FeNi_3$ nanoparticles for flexible planar micro-supercapacitor with ultrahigh energy density and quantum storage capacity. *Dalton Trans*., 48: 12137, 2019.

[3] **Talukdar, M.**, Nath, O., and Deb, P. Enhancing barrier properties of biodegradable film by reinforcing with 2D heterostructure. *Applied Surface Science,* 541, 148464, 2021.

[4] **Talukdar, M.**, Behera, S.K., Jana, S., Samal, P., and Deb, P. Band Alignment at Heterointerface with Rapid Charge Transfer Supporting Excellent Photocatalytic Degradation of Methylene Blue under Sunlight. *Adv. Mater. Interfaces,* 9(7): 2101943, 2022.

[5] **Talukdar, M.**, and Deb, P. Recent progress in research on multifunctional graphitic carbon nitride: An emerging wonder material beyond catalyst. *Carbon,* 192: 308-331, 2022.

[6] **Talukdar, M.**, Kuthethur, R., Banik, S., Mazumder, N., Chakrabarty, S., and Deb, P. Biocompatibility and in vitro cytotoxicity assessment of graphitic carbon nitride based fluorescent probe for imaging of breast cancer cell. *Materials Letters,* 333:133674, 2023.

❖ Patents

[1] Deb, P. and **Talukdar, M.** Two dimensional heterostructure based composite films for food packaging. (Filed Patent Application no. 201931014698).

[2] Deb, P. and **Talukdar, M.** Two dimensional graphitic sheet for viscous oil removal. (Filed Patent Application no. 201831009592) (***This has been awarded the Visitor's award for Technology development-2020***)

[3] Deb, P. **Talukdar, M.** and Sahoo, S. S. Biodegradable heat shrinking film for cylinder gas cap and bottle lid sealing. (Filed Patent Application no. 202231042538)

❖ . Outside thesis (UGC care listed)

[1] Sharma, M., **Talukdar, M.**, and Deb, P. High connectivity hierarchical porous network of polyurethane engineered by nanoflakes for proficient oil recovery. *Applied Surface Science*, 601:154210, 2022.

[2] **Talukdar, M.**, Sahoo, S. S., and Deb, P. Printable biodegradable heat shrinkable film with accretion of 2D nanofiller. (Communicated).

❖ . Book Chapter (UGC care listed)

[1] **Talukdar, M.**, and Deb, P.

Book Chapter name: Nanostructured Carbon Nitrides for Sustainable Energy and Environmental Applications.

Chapter Title: Exploring Smart Graphitic Carbon nitride material towards flexible energy storage supercapacitor. (Elsevier)

❖ Papers presented in national and international conferences

[1] **M. Talukdar** and P. Deb. Hybrid nanocomposite as in in-plane electronic micro supercapacitor. Poster presentation at *ICAM – 2019 INTERNATIONAL CONFERENCE ON ADVANCED MATERIALS (ICAM), Organised By Centre for Nanoscience and Nanotechnology (CNN) Jamia Millia Islamia (A Central University), New Delhi, India.* , 6th-7th, March, 2019.

[2] **M. Talukdar** and P. Deb. Development of novel and smart 2D heterostructure based nanocomposite film for sustainable food packaging. Poster presentation at *FSSAI's participation 27th Indian Convention of Food Scientists and Technologists (ICFoST)* 30th January to 1st February, 2020, Tezpur University, Assam.

[3] **M. Talukdar** and P. Deb Inimitable Type-II heterostructure with strong interfacial contact for toxic heavy metal removal. Poster presentation at *National Conference on Emerging trend in Physics (NCETP-2021),* held at Tezpur University.(Received best poster award)

[4] **M. Talukdar** and P. Deb Biodegradable flexible packaging material-One step towards better environment. Oral presentation at *Innovative Idea Competition conducted during the daylong workshop on "Intellectual Property Rights & Technology Transfer and their Role in promotion of Innovations" organized by School of Basic Sciences, Assam Kaziranga University, Jorhat, Assam in collaboration with DPIIT IPR Chair, Tezpur University and NRDC, Delhi on 4th March, 2022. (Received Second Prize).*