Graphene Oxide Lamellar Membrane with Enlarged Inter-Layer Spacing for Fast Preconcentration and Determination of Trace Metal Ions

Hilal Ahmad[1,2], Fohad Mabood Husain,[3] Rais Ahmad Khan[3]*

[1]Division of Computational Physics, Institute for Computational Science, Ton Duc Thang University, Ho Chi Minh City, Vietnam. Email: hilalahmad@tdtu.edu.vn

[2]Faculty of Applied Sciences, Ton Duc Thang University, Ho Chi Minh City, Vietnam.

[3] Department of Food Science and Nutrition, College of Food and Agriculture, King Saud University, Riyadh-11451, Saudi Arabia.

[4]Department of Chemistry, College of Science, King Saud University, Riyadh-11451, Saudi Arabia.

*Corresponding author E-mail: *krais@ksu.edu.sa*

Synthesis of graphene oxide (GO)

Graphene oxide (GO) was prepared from natural graphite powders by a modified Hummers method. In a typical process, a 200.0 mL of H_2SO_4 (95%) was added into a flask and cooled in an ice bath. Then, 5.0 g of graphite powder and 2.5 g of $NaNO_3$ were added under vigorous stirring to avoid agglomeration. After the graphite powder was well dispersed, 15.0 g of $KMnO_4$ was slowly added over about 2 h under stirring at temperature below 10 ^{0}C. The ice bath was then removed and the mixture was stirred at room temperature (30 ^{0}C) for 5 days. As the reaction progressed, the mixture gradually became thick and the color turned light brown. The 350.0 mL water was slowly added to the paste with continuous stirring and the temperature was kept below 98 ^{0}C. The diluted suspension was stirred at 98 ^{0}C for a day. After the temperature was reduced to 60 ^{0}C, 50.0 mL of 30% H_2O_2 was added in to the mixture to eliminate the excess MnO_4^-. Finally, the mixture was filtered and washed with 2 M HCl to remove metal ions, then washed with doubly distilled water until the pH was 7.0. The mixture was then dried at 80 ^{0}C. The

obtained powdered graphite oxide was exfoliated to GO sheets by bath ultrasonication (500 W, 40 kHz) for 2 h and was subjected to centrifugation at 3000 rpm to remove any unexfoliated graphite oxide. The prepared carboxyl rich GO sheets were used to prepare GO-APA membrane in the subsequent step.

Preparation of GO Membrane

Typically, 10 mg of GO powder was dispersed in 100 mL of deionized water under ultrasonication for 30 minutes. Then, 50 mL of this GO suspension was filtered through a cellulose nitrate membrane (0.22 μm) under vacuum filtration to fabricate the GO membrane adsorbent. Afterward, the fabricated membrane was washed with deionized water to remove any impurities, if present. The obtained GO membrane was dried in an oven for further use.

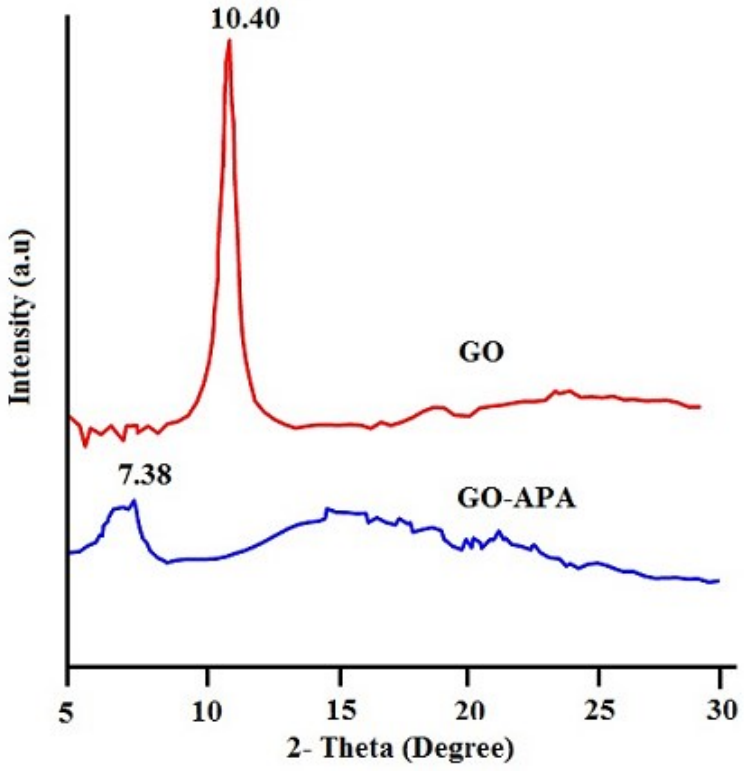

Figure S1: XRD patterns of GO and GO-APA membrane.

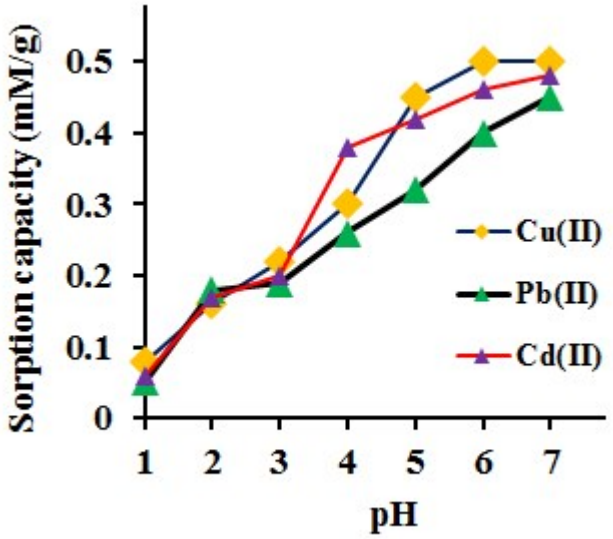

Figure S2: Effect of pH on the adsorption of metal ions onto GO membrane.

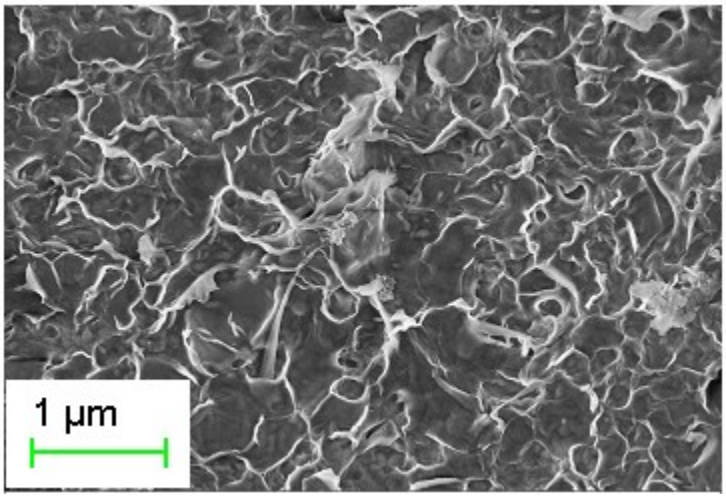

Figure S3: FESEM image of GO-APA membrane after 40 adsorption-desorption cycles.