Plasma Synthesis of Graphene from Mango Peel

Javishk Shah[1], Janneth Lopez-Mercado[2], M. Guadalupe Carreon[3], Armando Lopez-Miranda[4], and Maria L. Carreon[1].*

[1*]University of Tulsa, Chemical Engineering Department, 800 South Tucker Drive, 74104-9700 Tulsa, Oklahoma, US.

[2] Instituto Tecnológico de Estudios Superiores de Zamora, Departamento de Ingeniería de Industrias Alimentarias, Km 7 Carretera Zamora-La Piedad S/N. Colonia el Sauz de abajo, 59720, Zamora, Michoacán, Mexico.

[3] UMSNH, Ciudad Universitaria, Instituto de Investigaciones Quimico-Biologicas, Gral. Francisco J. Mugica SN, Felicitas del Rio, 58040, Morelia, Michoacan, Mexico.

[4]Centro Nacional de Metrología, Dirección de Materiales de Referencia, Carretera a los Cues km. 4.5, 76246, El Marques, Queretaro, Mexico.

Thermogravimetric Analysis (TGA) of Commercial Cellulose

The Thermogravimetric Analysis (TGA) was performed on a Perkin Elmer Pyris 1 Thermo Gravimetric Analyzer with the temperature ramp of 25 °C min^{-1} from 50 °C to 750 °C (reaction temperature) and a hold time for 12 minutes at 750 °C. The analysis was performed in a Helium flow of 60 ml min^{-1}. These conditions are the same employed for the commercial pectin and the mango peels. We employed commercial cellulose from Alfa Aesar (Cellulose, microcrystalline). In **Figure S1** it is possible to observe the decomposition of cellulose at around 364 °C.

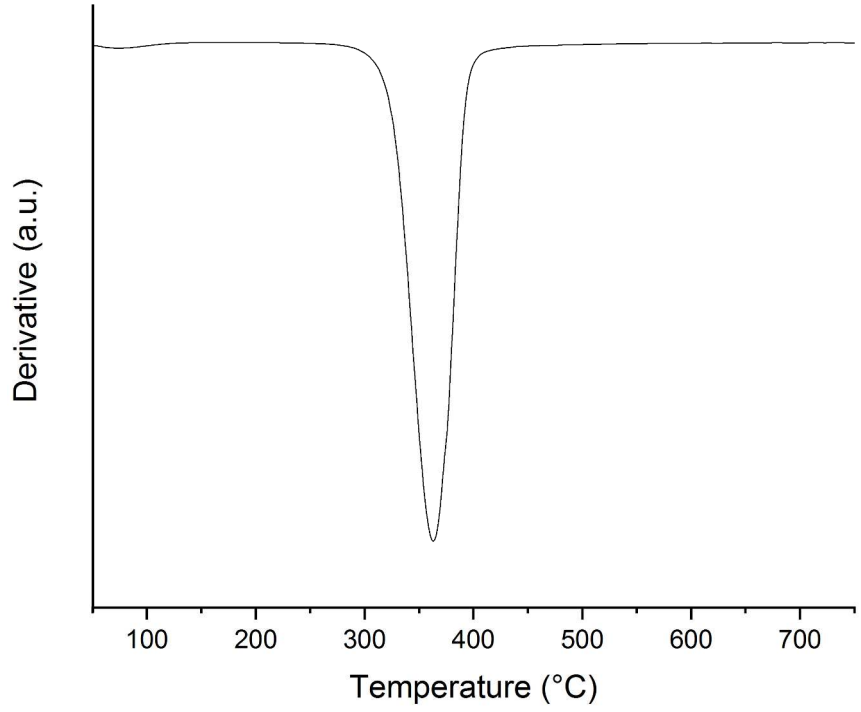

Figure S1. Thermogravimetric Analysis (TGA) of commercial cellulose.

Pectin extraction from Mango Peels

The Mango peels (*mangifera induca L.)* type kent is considered rich in pectin. We extracted the pectin from the mango peel by acid hydrolysis extraction, a common method for this purpose[1]. We employed 3g: 10ml [Mango Peel: to acid solution ratio (H_2SO_4)] with a PH = 2, 80°C and 45min, with continuous stirring. We obtained ≈ 18% of pectin, dry base. The obtained pectin was analyzed by ATR-FTIR and we compared with the commercial pectin (citrus, VWR) (**Figure S2**). We observed characteristic peaks and just small variations in the absorption bands. The peak at 3331 cm^{-1} is attributed to the O-H stretching, due to the inter- and intramolecular hydrogen bonds in the galacturonic acid. The 2921 cm^{-1} band corresponds to the C-H stretching, including the C-H, C-H_2, CH_3 variations[2-3], and as it can be observed is intensity is higher for the pectin extracted from Mango peels. The 1732 cm^{-1} and 1626cm^{-1} bands are associated to carboxilic groups[4]. There are some differences in the bands attributed to the degree of esterification of each respectively[4]. The "fingerprint" region of pectin can be found in the region below 1500 cm^{-1} [2, 4] where the variations are due to the differences in –CH_3CO (1228 cm^{-1}) variations, stretching of C-O (1015 cm^{-1}) and the shoulder localized at 1143 cm^{-1} associated to the pyranose rings[3].

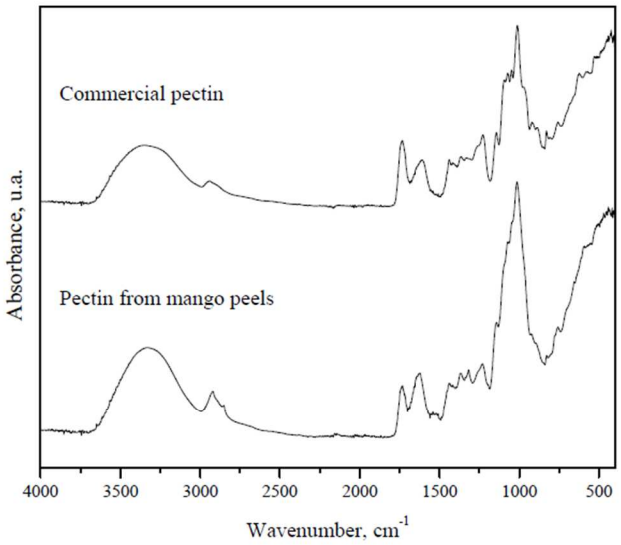

Figure S2. ATR-FTIR spectrum of pectin: commercial and Mango peels

Representative SEM image of a sample synthesized at 120 minutes

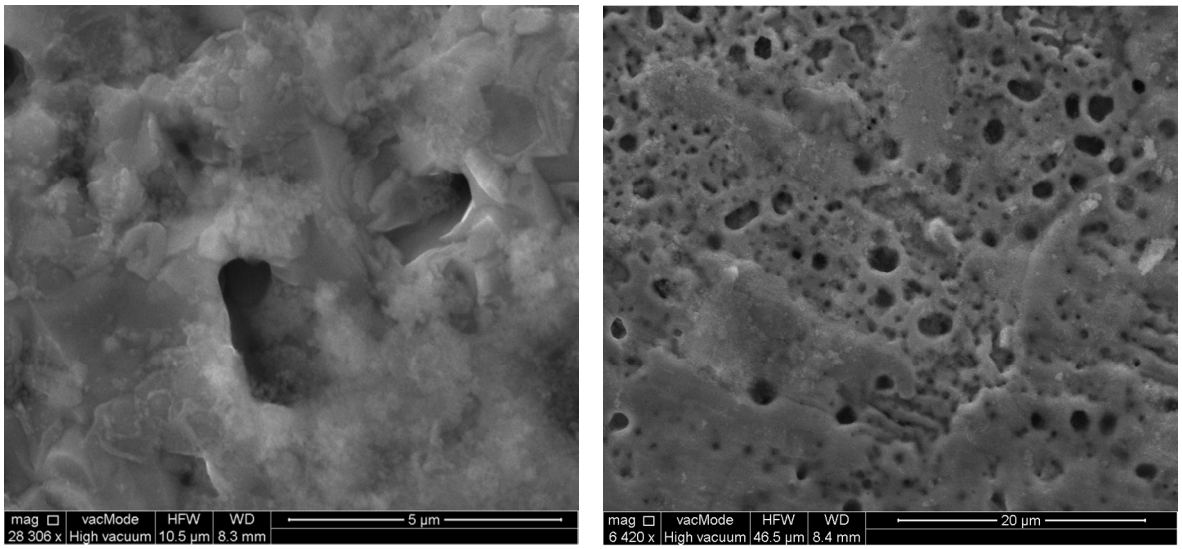

Figure S3. SEM images of sample exposed to plasma for 120 minutes

References

1. Srivastava, P.; Malviya, R., Extraction, characterization and evaluation of orange peel waste derived pectin as a pharmaceutical excipient. *The Natural Products Journal* **2011,** *1* (1), 65-70.
2. Karnik, D.; Jung, J.; Hawking, S.; Wicker, L., Sugar beet pectin fractionated using isopropanol differs in galacturonic acid, protein, ferulic acid and surface hydrophobicity. *Food Hydrocolloids* **2016,** *60*, 179-185.
3. Alba, K.; Laws, A. P.; Kontogiorgos, V., Isolation and characterization of acetylated LM-pectins extracted from okra pods. *Food Hydrocolloids* **2015,** *43*, 726-735.
4. Urias-Orona, V.; Rascón-Chu, A.; Lizardi-Mendoza, J.; Carvajal-Millán, E.; Gardea, A. A.; Ramírez-Wong, B., A novel pectin material: extraction, characterization and gelling properties. *International journal of molecular sciences* **2010,** *11* (10), 3686-3695.