國立臺東大學
NATIONAL TAITUNG UNIVERSITY

胺基酸在水中輔助分散二硫化鉬及石墨

Exfoliation MoS_2 and Graphene by Amino acid in water.

Abstract

Recently, the climate has been changing enormous. Therefore, we must seek alternative energy sources that are more environmental friendly and sustainable. Hydrogen energy is a clean, substitute energy source. When hydrogen is burned it releases only water (H_2O) so it can be reused without causing environmental pollution. Because of two-dimensional materials has superior electronic transmission performance and high surface area. Therefore that has extensive application in the fields of generate hydrogen as well as catalysis. Consequently it is important to prepare two-dimensional materials. However layered S-Mo-S sandwiched structures held by relatively van der Waals force so it is difficult to exfoliated to a single layer structure. Moreover, a single layer is prepare of fast, simple and green method. Here, we are not only propose the liquid phase exfoliation method using harmless and necessary amino acids to exfoliated MoS_2 and graphite but also discusses what structure of the amino acids has better dispersion results. Moreover we tested exfoliated MoS_2 to hydrogen evolution reaction and found it has a good overpotential. Accordingly since it was exfoliated by using human essential amino acids therefore it would has a widly range of applications.

Result

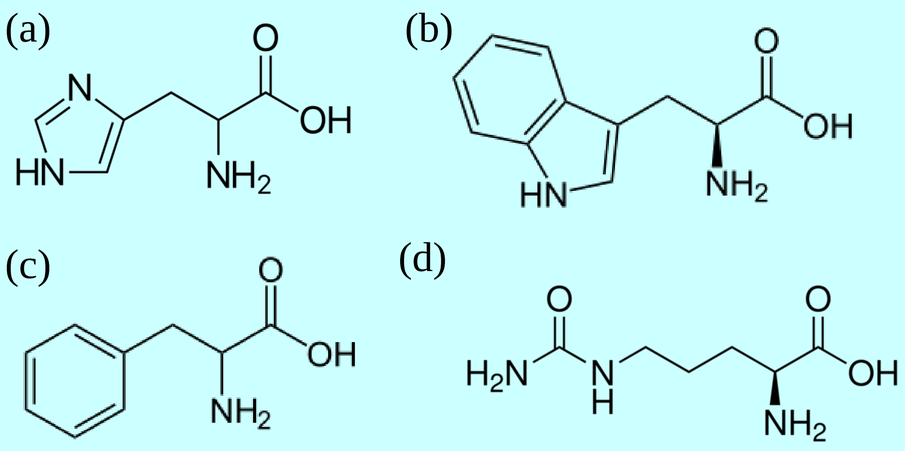

Figure 1. Amino acid chemical stracture. (a) Histidine. (b) Tryptophan. (c) Phenylalanine. (d) Citrulline.

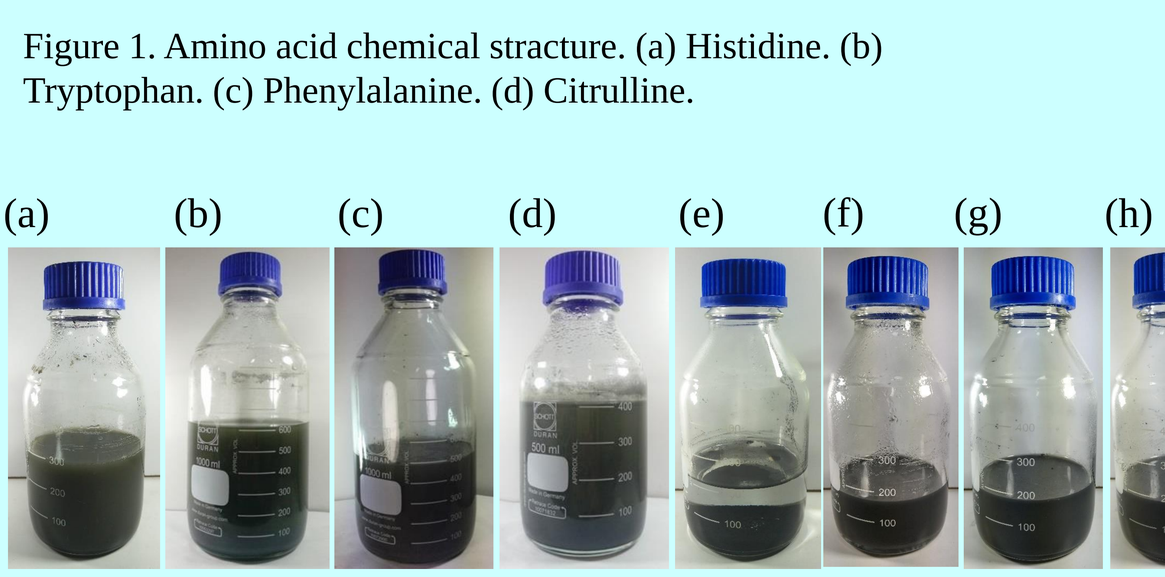

Figure 2. Actual photo of the MoS_2 dispersion.(a)-(d). (a) Citrulline. (b) Histidine. (c) Tryptophan. (d) Phenylalanine. Actual photo of the Graphene dispersion.(e)-(h). (e) Citrulline. (f) Histidine. (g) Tryptophan. (h) Phenylalanine.

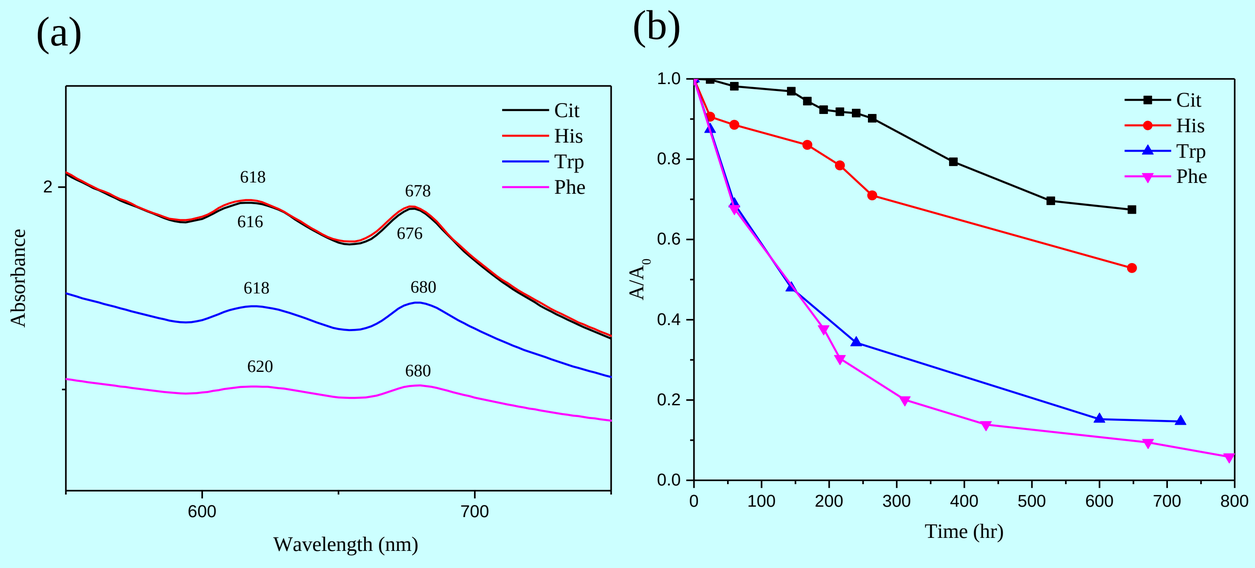

Figure 3. (a) UV/Vis spectrum of MoS_2 dispersion. (b) stability of amino acid exfoliated. Black wire is citrulline. Red wire is Histidine. Blue wire is Tryptophan. Pink wire is Phenylalanine.

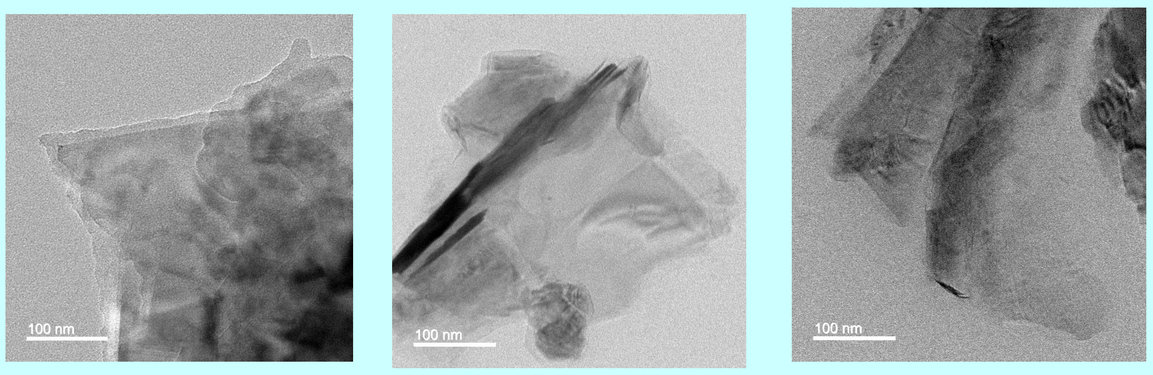

Figure 4. Morphological characterization of the MoS_2 exfoliated dispersion. TEM. (a) Histidine. (b) Tryptophan. (c) Phenylalanine.

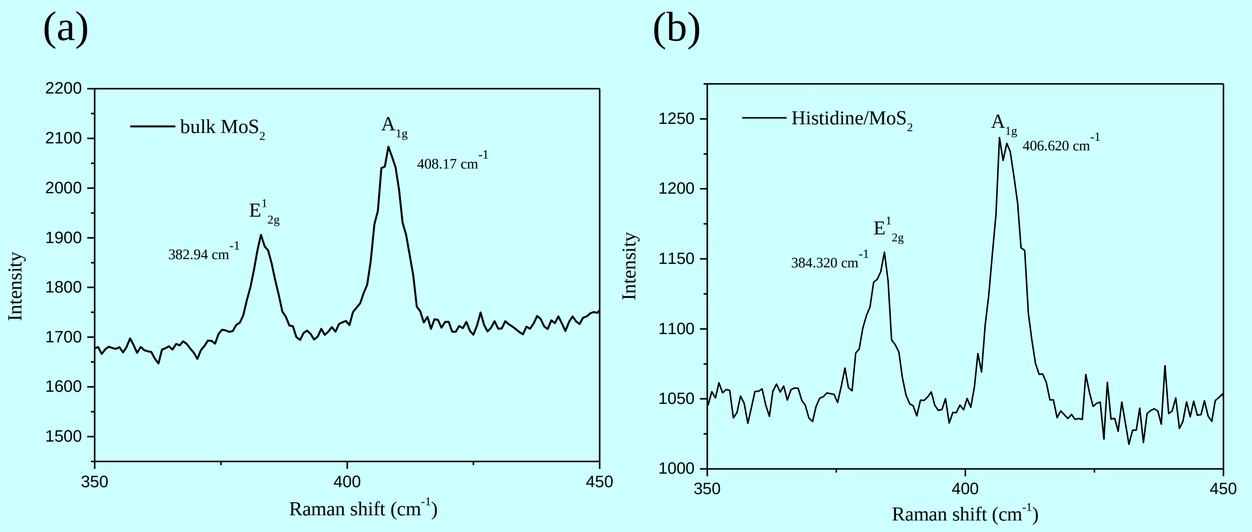

Figure 5. Raman spectra (a) bulk MoS_2 (b) exfoliated MoS_2.

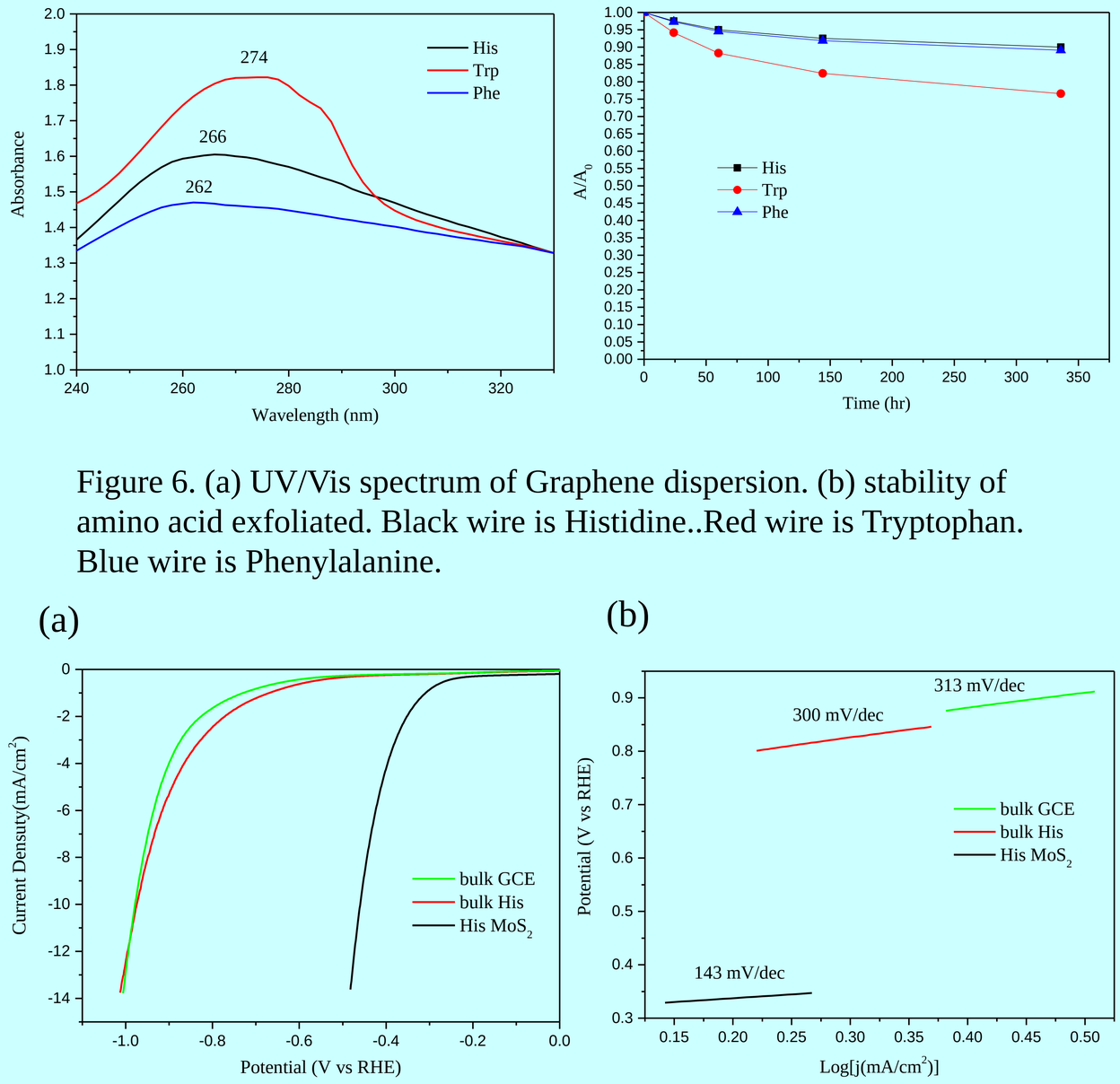

Figure 6. (a) UV/Vis spectrum of Graphene dispersion. (b) stability of amino acid exfoliated. Black wire is Histidine..Red wire is Tryptophan. Blue wire is Phenylalanine.

Figure 7. (a) LSV of the exfoliated MoS_2 for HER at the glassy carbon electrode in 0.5 M H_2SO_4 solution. (b) Tafel plot for the exfoliated MoS_2. Green wire is bulk GCE .Red wire is Histidine only. Black wire is exfoliated MoS_2.

Conclusion

In this experiment, we were successfully prepared single layer or a few layers MoS_2 and graphene by using human essential amino acids. In the exfoliated MoS_2 , Citrulline has the best dispersion effect because of a shorter carbon chain; followed by Histidine dispersion with two nitrogen in the ring and then is Tryptophan with one nitrogen in the ring ; finally is Phenylalanine without any nitrogen in the ring. The reason is that the layer-to-layer distance is easier for the structure with a short carbon chain to intercalated and separated. In the exfoliated graphite. Because of graphite has π-π interaction therefore Citrulline with only short carbon chains do not exfoliated graphite. To the contrary Histidine, Tryptophan and Phenylalanine has a ring and double bonds on it so that has well exfoliated effect. Afterwards we tested for hydrogen evolution reaction and found it has a good overpotential. In summary, we successfully used the amino acids to exfoliated MoS_2 and graphite. It resolve some problem in prepare TMDs and it would has a widly range of applications.