

Figure 4:  $I_{D'}/I_G$  versus reciprocal of lateral mean size

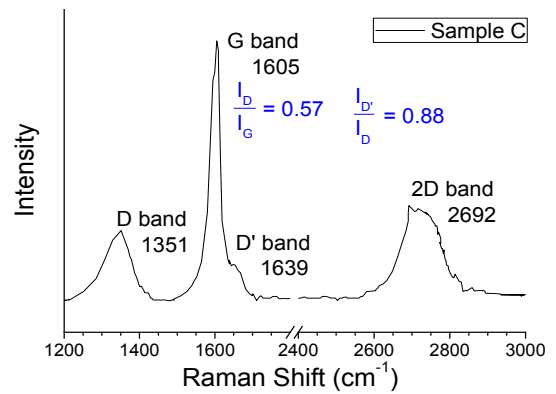


Figure 5d: Raman spectrum of graphene collected from supernatant after 135 mins

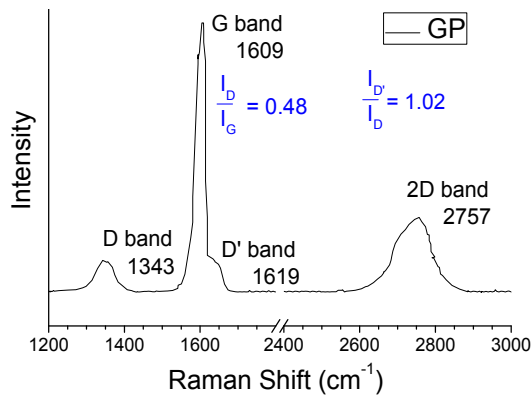


Figure 5a: Raman spectrum of pristine graphite (Bay carbon)

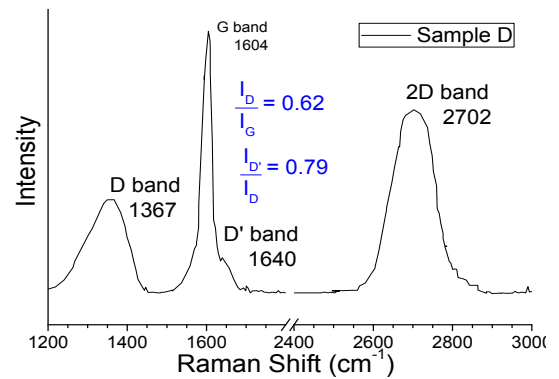


Figure 5e: Raman spectrum of graphene collected from supernatant after 180 mins

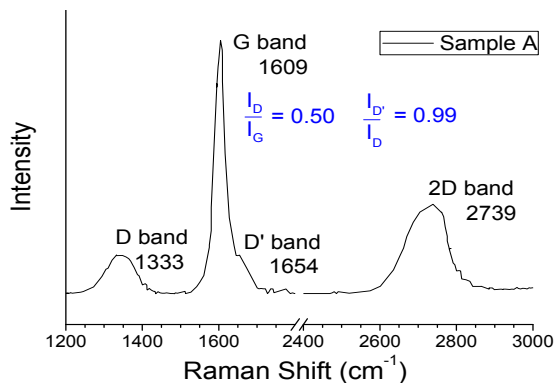


Figure 5b: Raman spectrum of graphene collected from supernatant after 45 mins

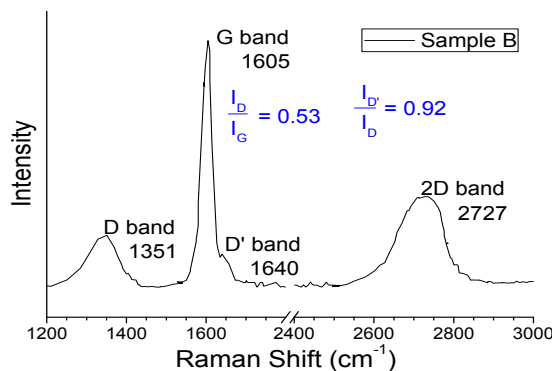


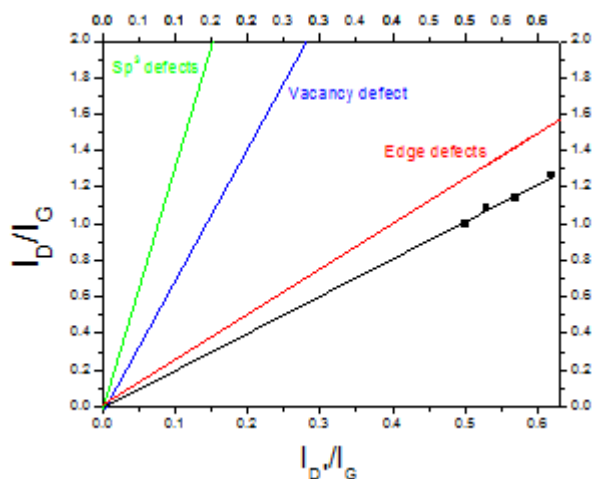
Figure 5c: Raman spectrum of graphene collected from supernatant after 90 mins

The slope of our straight line graph is 0.17, in conformity to the results reported elsewhere [23], an indication that equation 2 is a good approximation for size selection of graphene sheets, that is,

$$L = \left( \frac{0.17}{I_D/I_G - 0.48} \right) \dots \dots \dots (3)$$

Consequently, the mean lateral flake sizes obtained from our work were approximately 9, 3, 2 and 1 corresponding to samples A (45 mins), B (90 mins), C (135 mins) and D (180 mins).

However, in order to verify whether or not there was an introduction of basal plane defect into our graphene during the shearing process, a graph of  $I_{D'}/I_G$  versus  $I_D/I_G$  was plotted (see figure 6), and a slope of 2.21 obtained. Eckmann et al reported a slope of approximately 3.5 for edge defect, 7.0 for vacancy in the basal plane, and 13 for  $sp^3$  defects [24].



**Figure 6:** Ratio of intensities of D:G versus D':G for size evaluated graphene prepared through anionic surfactant shear method as compared to Eckmann's et al [24]

This departure from the edge-, vacancy- and  $sp^3$  defect curves proves that no basal plane defect was introduced into our shear exfoliated graphene, under turbulent condition.

#### 4. Conclusions

In this paper, we have reported a facile and replicable route to graphene production using anionic surfactant and hydrotropes contained in household washing liquid. The graphene produced was not tainted with graphene oxide. This was confirmed by EDX measurement which revealed high weight percentage yield (84.49%). Raman characterization showed the exfoliation of graphene monolayer, 2 layer graphene, 3 layer graphene, 9 layer graphene, a D:G intensity band ratio of 0.48 for our starting powder (note that this is different for different source of graphite) and a slope of 2.21, from our  $I_D/I_G$  versus  $I_{D'}/I_G$  plot. This is a strong indication that during the shearing process, no basal or edge defect was introduced in our graphene. Ab-initio calculations [25] simulated graphene of  $sp^3$  type to be approximately 1.3, whereas Eckmann et al experiment put it at 13 [24]. The discrepancy adduced by the experimental group must have introduced so much error that their "hopping" component of the defect must have been exaggerated. We therefore conclude that our 2.21 slope must be somewhere between the cone bounded by edge and  $sp^3$  defects.

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