TECHNICAL REPORT

On

ENVIRONMENTALLY SUSTAINABLE SMART SYNTHESIS OF CARBON NANO MATERIAL ALONG WITH THE PRODUCTION OF HIGH VALUE ADDED FUEL AND ADDITIVES FOR THE CONCRETE MIXTURE FROM WASTE PLASTIC, A HAZARDOUS WASTE AROUND THE HIMALAYAN REGION

The methodology of producing graphene nanosheets from waste plastics incurs several steps as summarized in the following flow chart diagram **(Fig. 1 and Fig. 2).** Further, the production of graphene nanosheets was achieved by following the previously reported method by our group **(Sahoo et al., 2016, Sahoo et al. 2019)**. Briefly, the synthesis process of graphene nano sheets was started by collecting the waste plastics (about 35 kg; categorized PP, PE and PS) from flea market and local municipality. The collected plastics were chopped (11.21 mm length, and 5.75 mm width) finely in flake like shape with the help of shredder. The chopped plastics then washed in a washing unit with soap solution to remove the oily and greasy impurities, followed by drying. After performing these elementary stages of cleaning and drying, the waste plastics and bentonite nanoclay with disk like particle shape (mean particle diameter of 70 nm, heavy metal was found 0.005% with a pH range of 9.0– 10.5) were mixed thoroughly with the help of sample mixture unit in a definite ratio. This mixing of substrate with degradation reagent i.e. bentonite needs to be mixed properly in mixer. The sample mixture thus prepared has undergone slow pyrolysis (horizontal hollow cylindrical feeder unit with the capacity of 0.41 m3 made up of stainless steel) process in inert atmosphere of N2 gas at 400 ^{0}C. This step generates the backbone for the nucleation of graphene nanosheets with the separation of all the value added fuels, waxes and gases. This phase belongs to the slow pyrolysis up to 400 ^{0}C with the heating rate of 5 ^{0}C /min, which is necessary to remove all the oil containing hydrocarbons from the plastics (Fuel). This process involves the slow rate of the pyrolysis to ensure that all the oil containing hydrocarbons and the gases ranges from C1-C4 have been removed from the sample mixture. Further, as the process of the pyrrolysis also contains waxy substances, the slow rate of the pyrrolysis also reduces the tendencies of making waxy substances within the sample mixture, therefore enhances the percentage of the purity level of the graphene nanosheets during the final step. Once the process of the slow pyrrolysis has been completed, a black colored amorphous carbon type charred residue was obtained. Further, a simple ignition test was also conducted for a number of randomly collected samples from the bundles of the black residue obtained after the slow pyrrolysis to ensure that all the oily hydrocarbons and waxy substances have removed during the slow pyrrolysis. The slow pyrolysis in this temperature causes the nucleation of amorphous, porous and shinning black charred residue, which was collected after the cooling of pyrolysis unit at room temperature **(Fig. 1a).**

The amorphous black charred residue thus collected from the primary step is placed in the ball mill unit to make the ultra fine powder before undergoing the secondary heating process in inert atmosphere, to increase the productivity of the graphene nanosheets in the system. The ultra fine powder thus obtained from the milling of amorphous carbon residue then undergoes fast heating process in the secondary reactor (consists a vertical cylindrical feeder unit with the capacity of 0.06 m3) at 750 ^{0}C with the heating rate of 10 ^{0}C /min in inert atmosphere of N2 (20 ml/min), where black colored graphene nanosheets were obtained **(Fig. 1b).** The removal of used nanoclays is necessary to maintain the purity of the product, which was achieved by washing with distilled water and mild acidic treatment with 5% HCl. After several experiments, we have optimized these two temperatures to synthesize the few layers of graphene successfully.

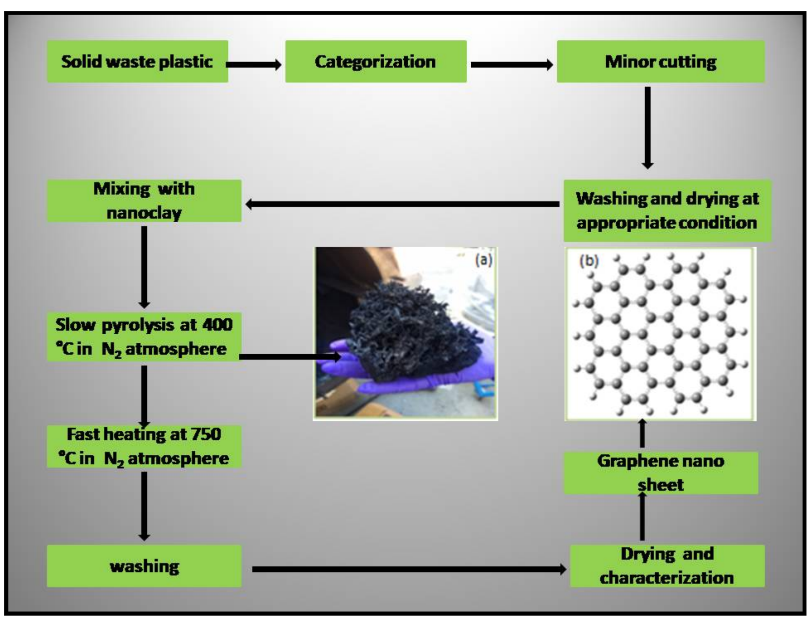
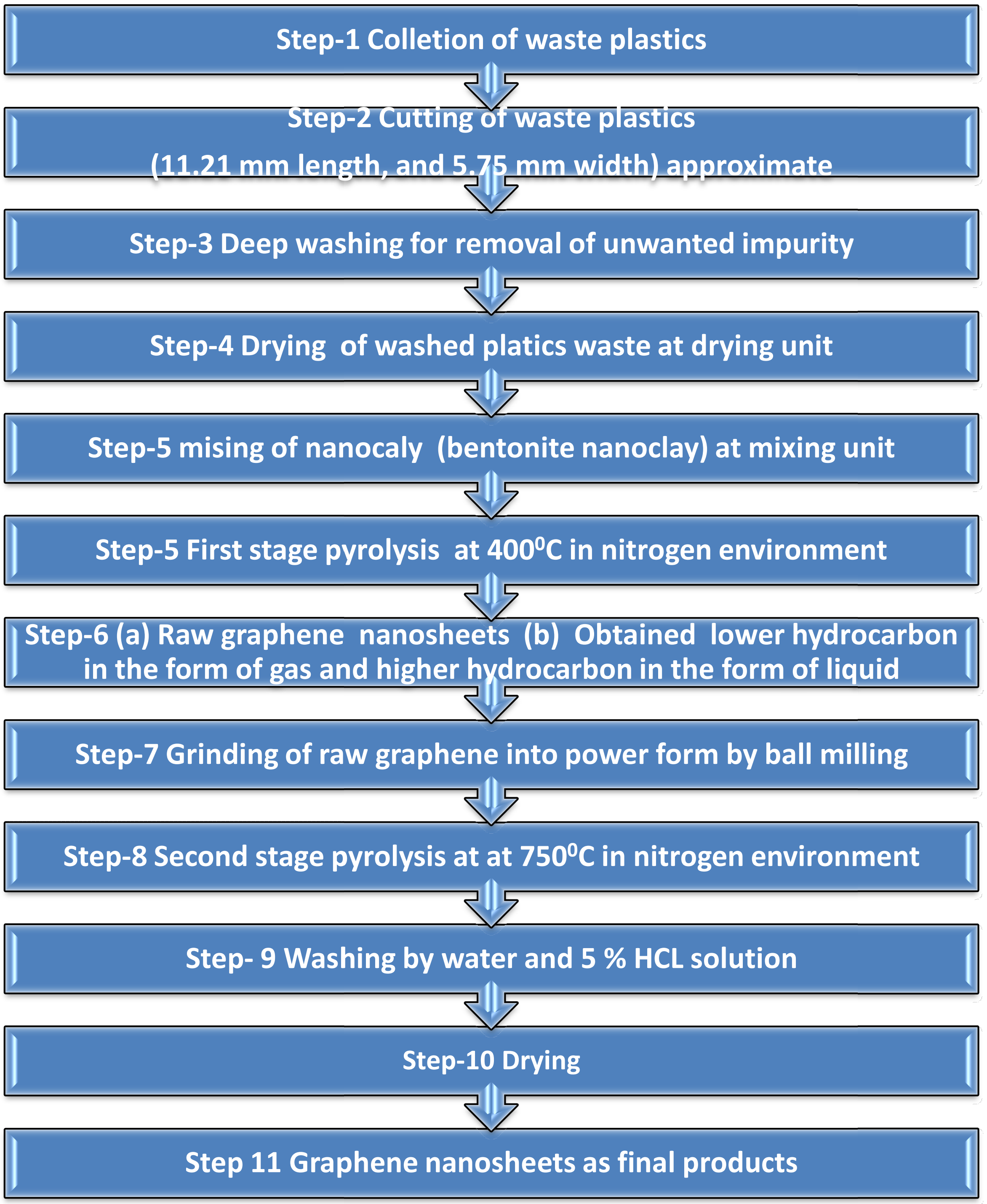


Figure (1) The methodology flow chart for the production of graphene nano sheets, (a) Physical state of Carbon residue obtained from slow pyrolysis, (b) Skeleton structure of graphene nano sheets after fast heating.

Stepwise procedure of synthesis of graphene nanosheets from waste plastics



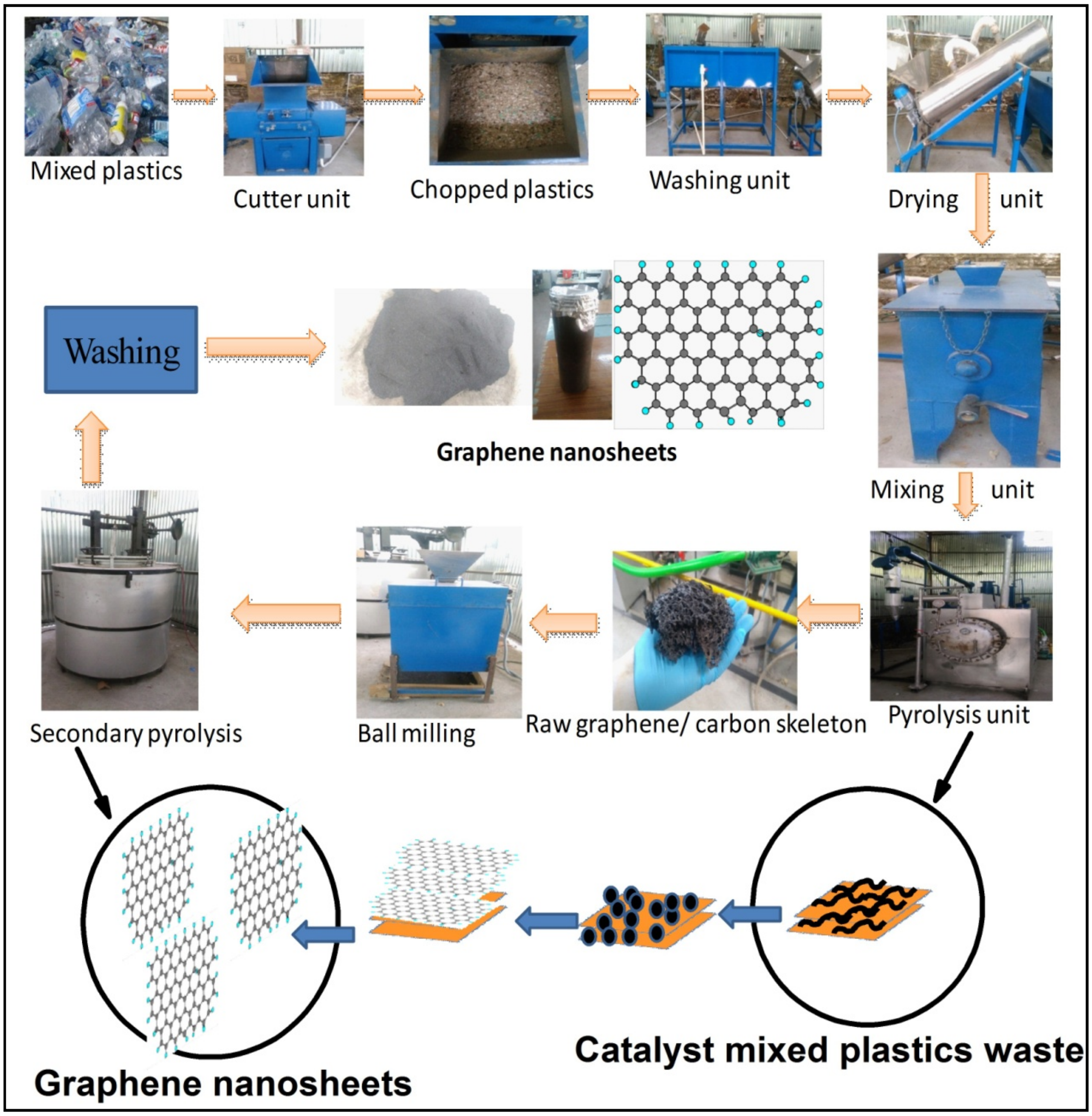


Figure 2 Flow chart for synthesis of graphene nanosheets from waste plastics

References

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[2] Pandey, S., Karakoti, M., Dhali, S., Karki, N., SanthiBhushan, B., Tewari, C., Rana, S., Srivastava, A., Melkani, A.B. and Sahoo, N.G., 2019. Bulk synthesis of graphene nanosheets from plastic waste: An invincible method of solid waste management for better tomorrow. *Waste management*, *88*, pp.48-55.