

Upcycling of Waste Plastics into Graphene: An Innovative approach towards “ Waste to Wealth”

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Waste not only generated the huge environmental problems but it also slows down the economical values the country. Not only the environment but also the human health greatly affect by the exponentially generating of waste materials. Rapid increase in urbanization and per capita income in India lead to high rate of municipal solid waste generation. In recent times, E-waste and plastic waste also contribute noticeably to total waste stream due to consumption of electronic and other items. These wastes may cause a potential hazard to human health or environment if any of the aspects of solid waste management is not managed effectively. In India, approach towards Solid waste management is still unscientific. Solid Waste collection efficiency in India is around 70%, while same is almost 100% in the developed countries. Even today, large portion of solid waste is dumped in towns or cities without any prior treatment. Especially, the waste plastics cause an alarming situation in front of all scientific community to manage it by the most cost effective technique.

Being one of the most populous nation and fastest growing economy, India cannot afford to ineffective solid waste management. It seems that policy framework is available only on paper, but ground reality is alarming one. Due to improper waste segregation and other factors lead recycling sector to work on outdated technology. However, plastic recycling have been especially growing due to continuous increasing consumption by human. There is an urgent need to implement the new, advance and sustainable technology which can solve the plastic waste issue in India.

Now in the our dream project context, before the working on the waste plastic, we (myself and my Ph.D. students of Nanoscience and Nanotechnology Centre, Department of Chemistry , DSB Campus, Nainital) are just dreaming and thinking about this plastics issue and always one

question arise, can we solve the issue of the plastic through the effective and greener way? In order to bring our dreams to the ground, we design a special type of reactor with capacity of 15 kg per cycle. This reactor made by local manufacturer with very low cost of Rs. 5000 (Figure 1). Through this reactor we got raw carbon from the waste plastic. After that it is characterized by different characterizing techniques which confirmed this raw carbon is graphene. Our group also conducts this experiment in the tube furnace in the inert environment and we get the same results with additional solid fuel. Considering these results our group came at this level to conduct this experiment in large scale with sustainable and greener way. Because, we have received the research project on “Environmentally Sustainable Smart Synthesis of Carbon Nanomaterial 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” under National Mission on Himalayan Studies from GBPIHED, Koshi-Katarmal and Ministry of Environment, Forest and Climate change in 2016.



Figure 1. Preliminary setup for waste plastic recycling

"You never fail until you stop trying", Yes!! this is the moto of our lab “Nanoscience & Nanotechnology Centre”, and we have proven it again. Three years back when our lab got established we worked on translating an Idea to reality for the great service and value for the society. I would like to take this opportunity that after two years of persistent efforts we are dedicating our Innovation **SWAYAMBHU WRM 2021** to the great service of our proud Nation. The SWAYAMBHU is a Sanskrit word which means this machine has own existence and run

itself. The machine successfully installed at Prof. Rajendra Singh Nanoscience and Nanotechnology Centre, Department of Chemistry, DSB campus, Kumaun University.

SWAYAMBHU WRM 2021 is the recycling machine which can deal with the huge planetary crisis of our time that is WASTE PLASTIC. Our Idea was to work on a lesser-known fact that plastic has a higher energy value than just about any other type of waste. We invented this machine which can convert waste plastic into fuel and wonder material Graphene (Figure 2) simultaneously for the first time. At this moment, we are getting the raw graphene about 12-15% and crude oil (25-40%) from the waste plastic through this machine. The breakthrough offers an effective way to deal with the pervasive problem of waste plastic and in addition provides an opportunity to create huge revenues by creating fuel and graphene. I am very hopeful that this innovation is really the one this Nation was looking for. After getting the products from the waste plastics it was characterized by different advanced analyzing techniques which confirm this material is graphene.



Figure 2. Graphene (left side) and Fuel (right side).

This kind of upcycling of waste plastics to graphene and its other by products not only gives the more economical value, but it also helps to the every citizen of India to enjoy its charming properties. Thus the overall projects seem to be cost effective and greener technique for the sustainable and environmentally friendly waste management to enhance the revolution of “Clean and Green India”.

The machine SWAYMBHU-WRM-2021 is one of unique waste recycling machine having capability for the complete solution of waste plastic is designed by us, thus definitely it will create history in advancement of Nanotechnology and waste recycling technology. As the host institution is being situated in Himalayan region, the place at which the idea is first generated to tackle the waste plastic problem in this way, thus it can help to give data firstly about this region for the assessment of environmental issues of Himalayan region cause by plastic littering. The waste management of policies of government about the plastic is not be cleared about its successful disposal, thus this innovation will surely benefits for the government to make the good policies about the waste. We have patented this innovation and transfer this technology to the industry for further commercialization.

Presently, we are using this synthesized graphene for many applications such as supercapacitor, solar cell, fuel cell, water purification, drug delivery etc. Also, our group dedicated to conversion of other solid waste such as paper waste, forest waste, agriculture waste etc into carbon nanomaterials.

