From Plastic Wastes to Carbon Nanotubes: a Novel Conversion

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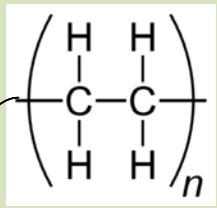
Pieces of milk jug, made of high density polyethylene (HDPE), and tears of newspaper's wrap, made of low density polyethylene (LDPE), were used as fuels to provide heat from their exothermic combustion along with the carbon source to synthesize carbon nano-tubes (CNTs). CNTs are generated under fuel-rich conditions, with an average equivalence ratio (ϕ) in the vicinity of 2.5. This research illustrates that is feasible to produce CNT in a commercial scale while reducing the waste in a green manner.

FY2007	Plastics* (in million tons)
Weight Generated	30.7
Weight Recovered	2.09
Recovery As a Percent of Generation	6.80%

*: EPA Annual Report

Landfills: an expedient for current plastic waste handling

PE: 60%wt of total plastic waste



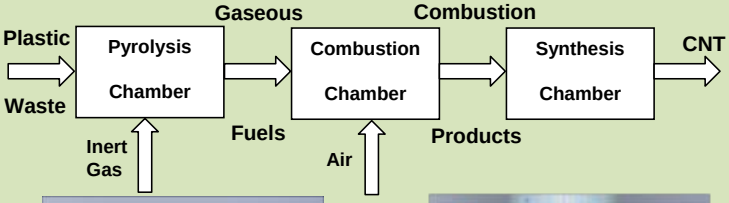
Milk Jugs, Water Pipes, etc.

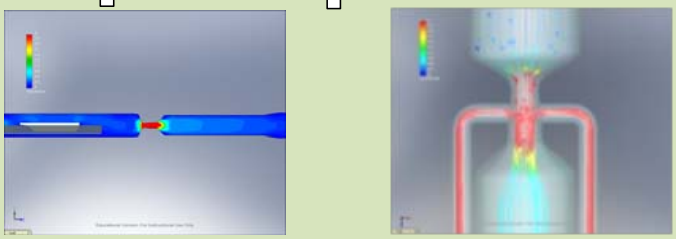
Plastic Bags, Trays, etc.

Carbon: material source for CNT, contained in the pyrolysis products of PE, mainly ethylene (50%), methane (20%), acetylene (6%) and propylene (3%). (Gonçalves et al., 2007)
CNT: a novel material with unique properties.
Best specific strength known in nature, 300 times than high-carbon steel;
Excellent electric conductivity, 1000 times than copper.

Heating Value: 46,000KJ/KG,
Provides energy for the pyrolysis and the CNT synthesis along with the extra process heat

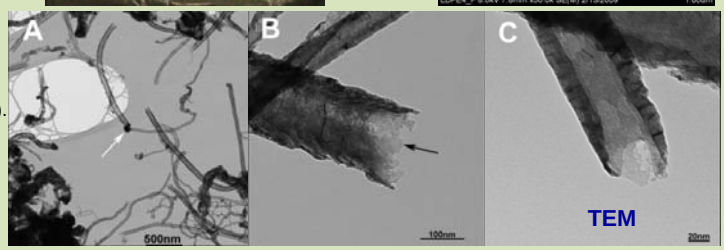
Conversion System





Top: System schematic for the wastes-to-CNTs conversion system.
Bottom: Simulations on the velocity distribution along the boat and venturi (left), and a zoom-in view of the flow around the venturi, where fuel and air get mixed

Wastes → CNTs **(SEM)**



First and second rows: **SEM** images of material grown from PE pyrolyzates on a stainless steel mesh coated with 8 nm nickel. Bottom row: **TEM** images of the same type of materials after dispersion in ethanol and deposition on holey carbon grids.

Results and Observations

- **Carbon nanotubes (CNTs), with the length up to 4μm and ranging from 20nm to 100nm in diameters, were achieved within 30seconds.**
- **At least 1.7‰ of the carbon by weight can be converted to high-value CNTs.**
- **Deducted by the heat used for the pyrolysis of PE, 254KJ/KG (Jinno, 2001, 2002), the whole process is overwhelmingly extrothermal. A portion of the heat released during the polymer combustion will be used in a heat-exchanger/pyrolyzer unit to gasify incoming precursors; whereas the remaining heat can be used elsewhere as process-heat.**
- **Generally, the type of polymers, HDPE and LDPE, does not show significant influences on the products, in terms of morphology, dimension, and products yields.**

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