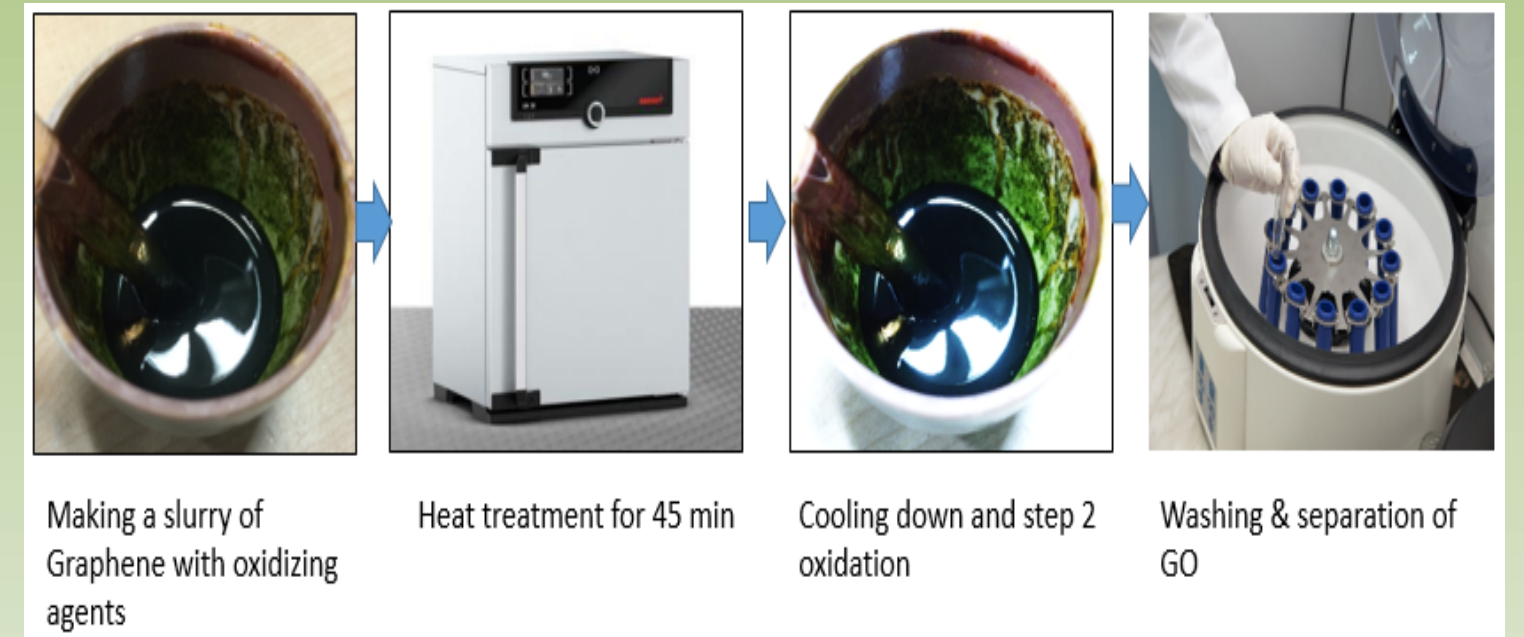


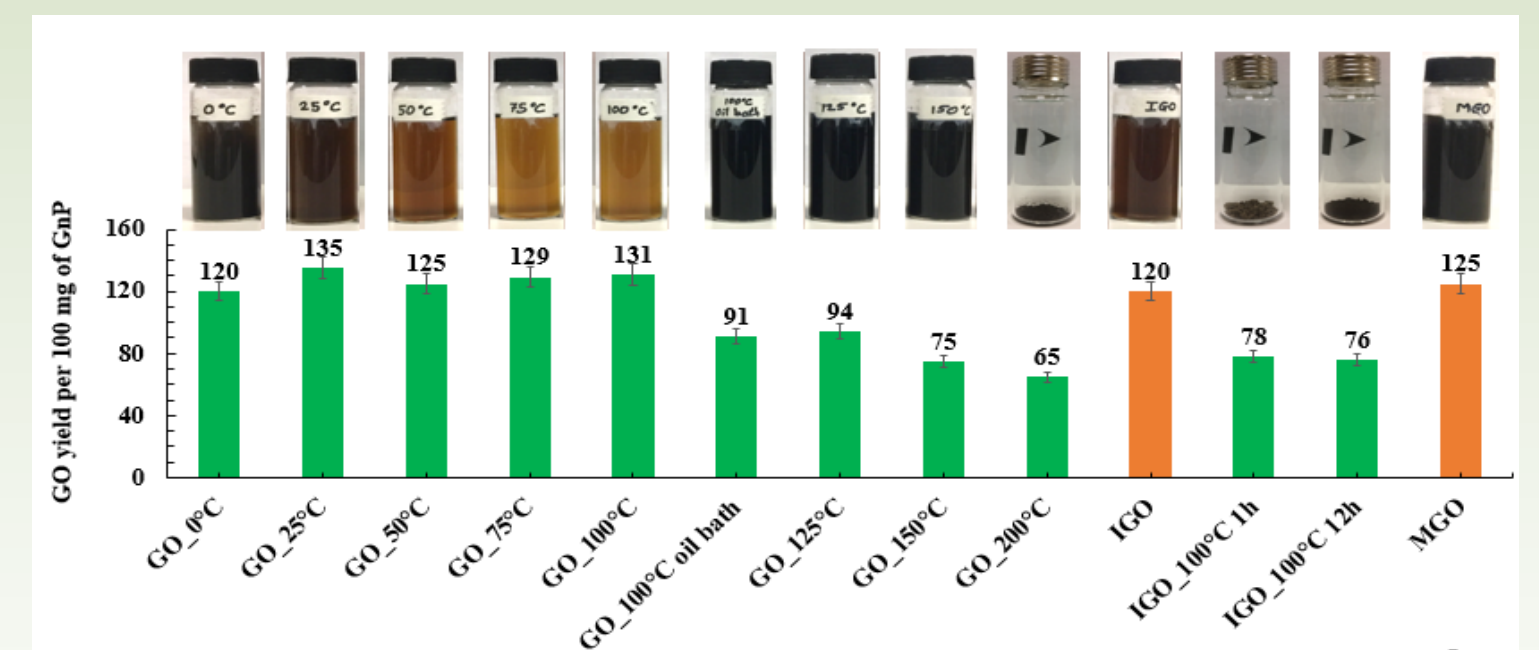
GRAPHENE OXIDE PRODUCTION (Fast and Easy Method)

Technology Overview

Graphene oxide (GO) is a key product segment in the graphene market which will account for around 40% of the total industry revenue share in 2024. However, the high cost of GO is limiting the application. The current methods of GO production has few limitations such as longer oxidation time, formation of defects (poor quality), large volume of acid usage, toxic gas evolution etc. The high cost of GO is mainly associated with the complex and tedious oxidation processes as well as the huge volume of chemicals used EWTCOI has developed a simple, fast and eco-friendly method of GO production.



EWTCOI's new GO production method



Yield & quality of TGO in comparison with MGO/IGO

GO synthesis method	Hummers method	Improved Hummers method	Modified Hummers method	Oxidation via thermal treatment Our Method
Name	HGO	IGO	MGO	TGO
Exotherm	Exotherm.	No large exotherm.	Exotherm.	No exotherm.
Gases evolved	NO ₂ gases evolved.	No toxic gases evolved.	NO ₂ gases evolved.	No toxic gases evolved.
Oxidation level	Less oxidized.	More oxidized.	Slightly less oxidized than IGO.	More oxidized.
Structural changes	Chances of excessive oxidation and hole or defects formation.	Higher fraction of well oxidized hydrophilic material and less disrupt basal plane compare to modified method.	Chances of excessive oxidation and hole or defects formation.	Higher oxygen containing functional groups. No chances of defects and hole formation.
Protecting agent (Second acid)	No second acid present. Excessive oxidation and formation of holes.	Second acid, H ₃ PO ₄	No second acid present. Excessive oxidation and formation of holes.	H ₃ PO ₄ minimized over oxidation by formation of cyclic intermediate resulting protection of vicinal diols formed during oxidation.
Oxidation time	Oxidation time about 18 h.	Oxidation time is high. At least 12 h.	Oxidation time is less, About 2 h.	1 h only.
Purification	Need exhaustively washing to remove remaining acids and Mn ions due to penetration of acid into material for long oxidation time.	Need exhaustively washing to remove remaining acids and Mn ions due to penetration of acid into material for long oxidation time	Need exhaustively washing to remove remaining acids and Mn ions due to penetration of acid into material for long oxidation time.	Less oxidation time benefit to easy removal of remaining acids and Mn ions during washing.



**Semi-automated GO production unit
(100g/batch)**

Technology Features

- Simple & easily scalable method
- Fast process (Reduced reaction time)
- High quality GO production
- Less chemical usage
- Eco Friendly production process (no NO₂ gas evolution)

Benefits

- Increased Production (due to fast process)
- Less chemical usage (Green process)
- Reduced cost (~10%)

Applications

- Coatings/Adhesives/Composites
- Sensors
- Energy storage devices
- Additives for Membrane
- Textiles
- Automotive parts fabrication

Market Opportunities

Graphene Oxide has numerous applications. The global Graphene Oxide (GO) market is valued at 6295 K USD in 2017 and is expected to reach 64504 K USD by the end of 2024, growing at a growth Rate of 39.44% between 2017 and 2024