AACOMA

Demo project #1

Title: 3D printable graphene based composite mono-filaments for energy storage devices (3D disc electrode)

Lead partner: AMIBM

Motivations and Goals

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Graphene

- 13x better electrical conductivity than copper
- 100x faster electron mobility than silicon
- 2x higher thermal conductivity than diamond

Why 3D Printing?

- Unique platform for rapid prototyping of numerous applications
- Produce low cost 3D printed objects

3D disc electrodes

- Applied as freestanding anodes within Li-ion batteries
- Solid-state super-capacitors

Why freestanding anodes?

- These freestanding anodes neglect the requirement for a current collector
- Offering a simplistic and cheaper alternative to traditional Li-ion based setups.

How will it be done?

- A graphene-based PA6 filament (graphene/PA6) will be 3D printed to fabricate a range of 3D disc electrode configurations
- Using a conventional RepRap fused deposition moulding (FDM) 3D printer

Challenges to address

- Several factors need to be considered while printing conductive composite materials.
  - One of the major bottlenecks is nozzle jam, caused by agglomeration of the nanofillers and resulting in poor printability and surface roughness

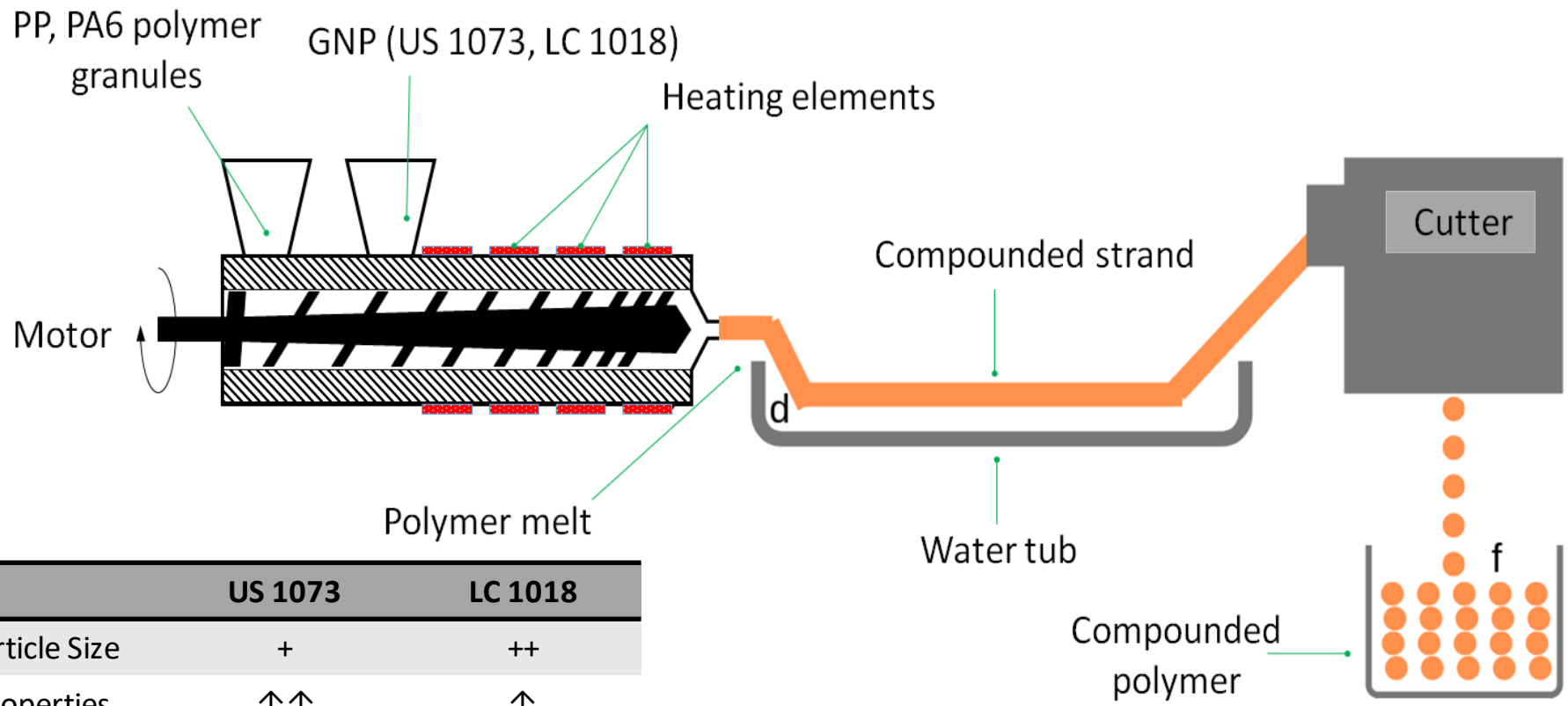
- In order to control these effects, the following parameters needs to be optimized
  - The size and size distribution of the conductive fillers
  - Parameters/conditions, such as printing temperature, printing speed, residence time and printing bed temperature.

- The conductive filament should have enough flexibility to be spooled after melt extrusion and fed through the tube of the 3D printer without breaking for 3D printing.

Compounding GNP's in polymer matrix

Graphene Selection

Technical Data



	US 1073	LC 1018
Particle Size	+	++
Properties	↑↑	↑
Price	€€€	€

PA6/GNP, PP/GNP mono-filaments

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Up to date, the highest graphene loading in composite mono-filaments used is up to 5.6 wt%.

Polyamide 6 + GNP

PA B24 + 3% GNP

PA B24 + 5% GNP

Polypropylene + GNP

PP HP 2674 + 3% GNP

PP HP 2674 + 5% GNP

PP + PA + GNP

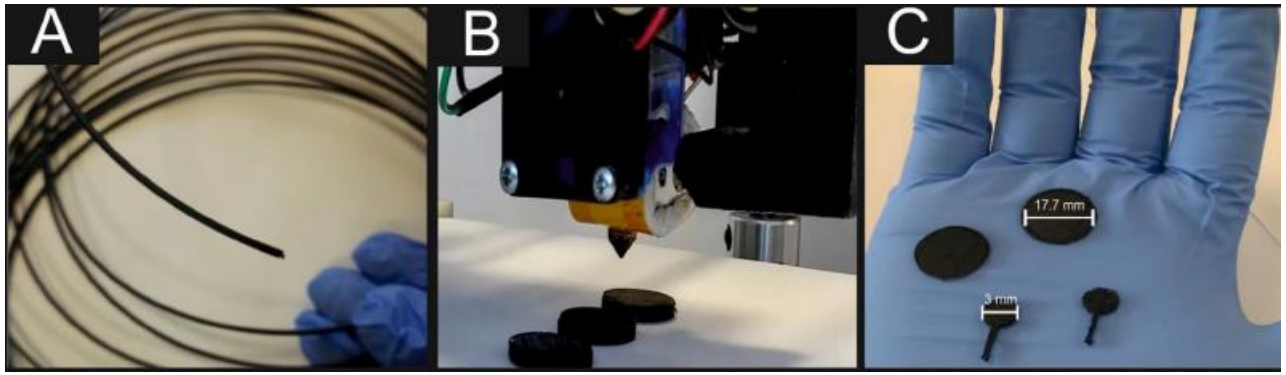
75% PP HP 2674 + 20% PA B24 + 5%GNP

Lab Scale

- **Xplore Minicompounder MC5**
- Batch processing (2-5 g)
- Winding speed ≤150 m/min
- Nozzles from 0,25-2 mm
- Force/Speed driven

These graphene-polymer composites were extruded into 1.75 mm diameter filaments to fit the commercialized 3D printer.

Disc electrodes from 3D printing



PA6/GNP mono-filament

FDM 3D-Printing

3D disc electrodes

Producing two 3D printed discs and sandwiching a solid electrolyte between the two

Applications

- **Applied as freestanding anodes within Li-ion batteries in laptops, mobiles, tablets.**
- **Solid state super capacitors**

Advantages

- **Neglect the requirement for a current collector**
- **Can be produced on conventional FDM printer**

Benchmark capacitance

	Current (µA)	Capacitance (µF)
1	0.5	28.12
2	10	10.46
3	50	8.08

Partners involved and Timeline

Partner	Task	Role of partner
AMAC	Materials procurement	Facilitating in finding the suppliers for the right material and cost performance benchmarking
AMIBM	Compounding	Producing PA6/GNP's and PP/GNP's compounds
AMIBM	Fiber spinning	Producing mono-filaments for 3D printing at micro-extruder
Fontys	3D printing	Producing 3D printed objects from mono-filaments
Industrial partner	Upscaling 3D printing	???

Task title	Responsible Partner	Duration
Compounding PA6/GNP, PP/GNP	AMIBM	05-2021
Fiber spinning	AMIBM	07-2021
3D printing	Fontys	09-2021
Upscaling 3D printing	???	04-2022

Thank you!

DEMO #1 project Leader

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