



**Óbuda University**

Doctoral School of Materials  
Science and Technologies



Neumann  
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# Preparation and Investigation of Nanocomposites with Polymer Matrix

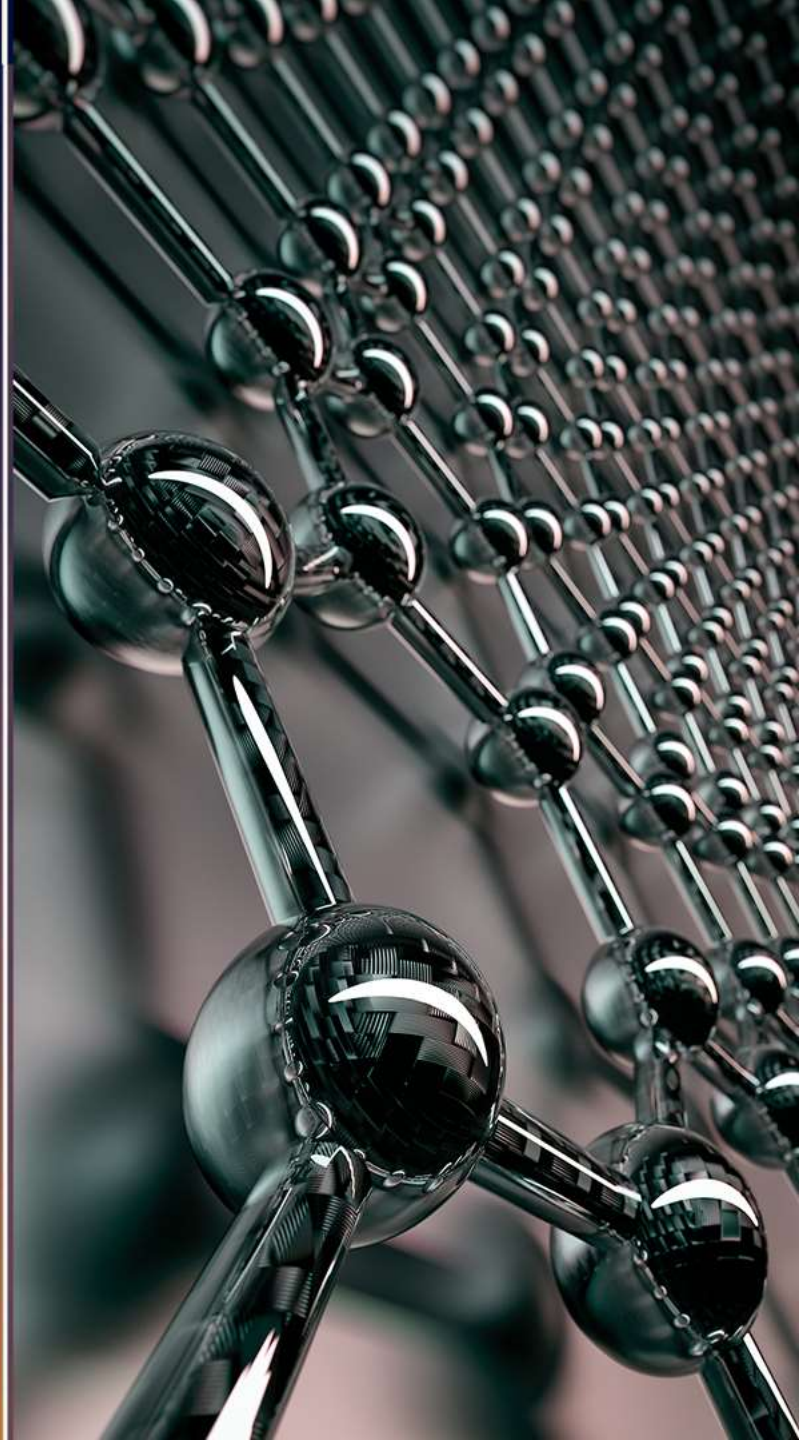
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## Summary of literature review

-There is an increasing need to create new materials of high efficiency and quality in the industrial applications to be used as alternatives to traditional materials.

- Composite materials are used, the most important of which is nanocomposite materials → they improve the properties of the polymer.

- Most nanofillers used for polymer composites are multi-walled carbon nanotubes.



The  
problem  
to be  
solved

Improving the properties of nanocomposites by adding MWCNTs to increase the investment life of these materials



Aim of the  
research



Study the effect of the addition of multiwall carbon nanotubes (MWCNTs) on the properties of polymer.





# Practical part

## Materials

Polybutylene Terephthalate (PBT)



Multi wall carbon nanotubes (MWCNTs)

Low humidity absorption

High strength and hardness

Resistance

Huge surface area to volume ratio

Mechanical and thermal strength

Increased ductility with no decrease of strength

Friction and wear resistance.

It is 100 times stronger than steel

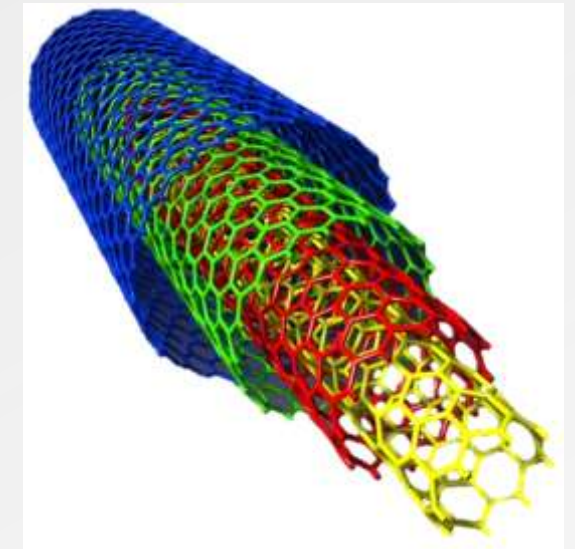
High temperature

Good wear

electricity

flame

motor oil, gasoline and brake fluids.





## Practical part

## Materials

### Acrylonitrile Butadiene Styrene (ABS)

High impact strength.

Inexpensive , strong and stiff

Excellent surface quality.

Holds up well to external impacts.

High dimensional stability at high temperature

Good chemical resistance.



### Polyamide 6.6 (PA6.6)

Good corrosion resistance.

High tensile strength.

Good dimensional stability.

High water absorption.

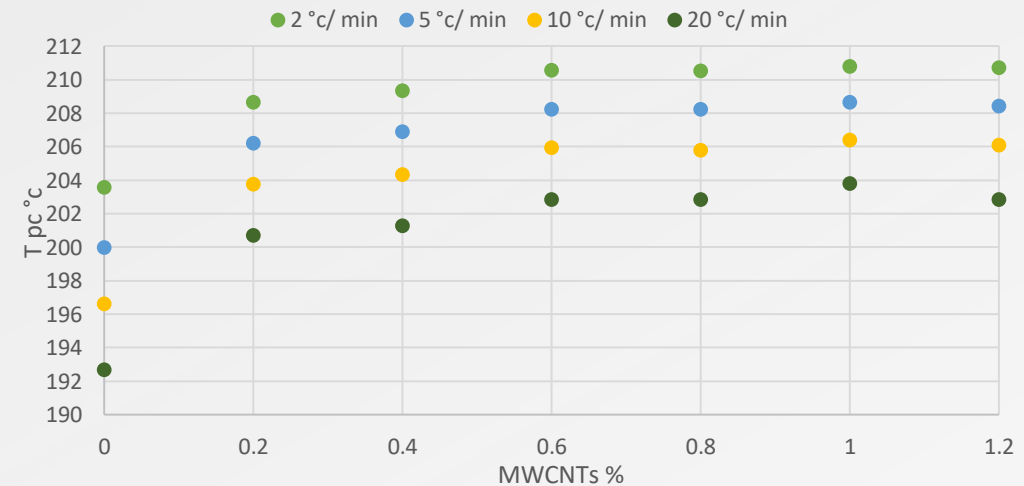
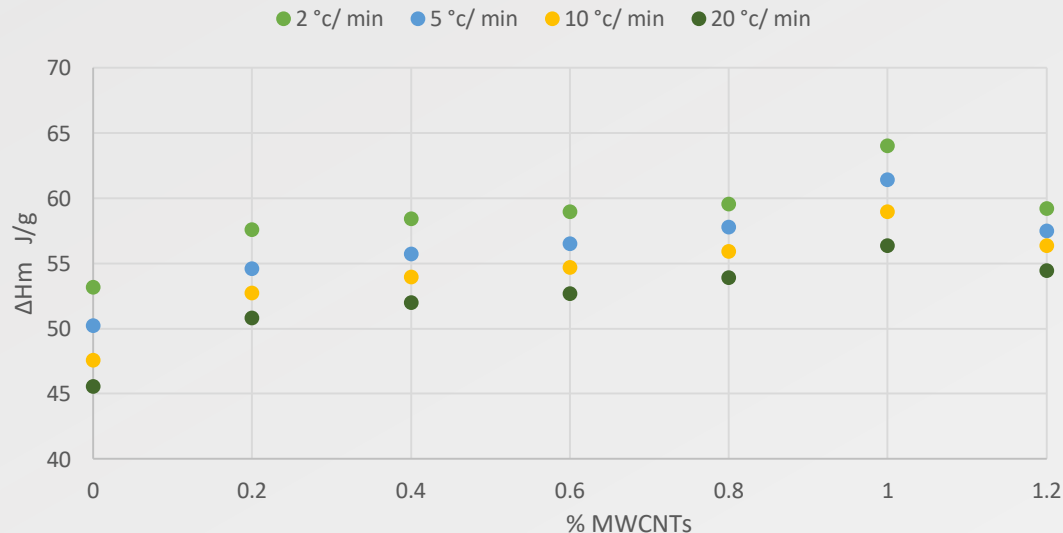
High temperature resistance.





## Practical part

- After determining the crystallization kinetics of the material in **non-isothermal** conditions
  - The results indicated that the change in crystallization temperature and melting rate depending on:
    - The ratios of MWCNTs.
    - Cooling rate.
  - The presence of MWCNTs:
    - Form a strong nucleating agent ➡ crystallization started at an early phase ➡ enhance the nucleation of PBT.
    - The structure of PBT became more stable.
    - Increasing the amount of crystallization ➡ change in the physical and chemical properties ➡ improve in the final properties of the composite.





## Practical part

### Isothermal crystallization of PBT/MWCNTs

1- We added MWCNTs to dried PBT with the following ratios 0.2, 0.4, 0.6, 0.8, 1, 1.2 % wt.

2- We put granular mix (PBT/MWCNT) into the extrusion machine which connected to the mixer at the temperature of 250 °C.

3- We scanned them by using a (DSC) to determine the crystallization kinetics of the material in **isothermal** conditions.



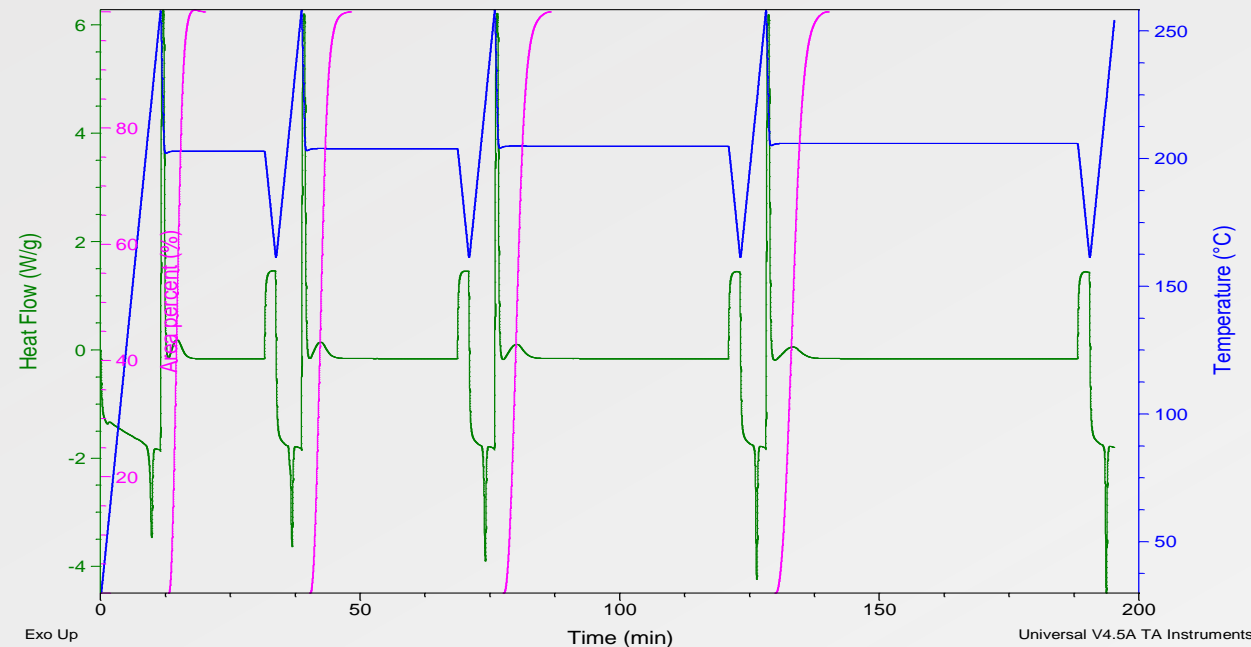




## The results

Where the results were as following

- The isothermal process is affected by the presence of MWCNTs → nucleation agents → the rates of the overall process.
- When increasing the ratios of MWCNTs, the temperature increased
- The addition of MWCNTs achieved higher crystallization rates than neat PBT → affecting its properties.



DSC traces for the isothermal crystallization of PBT with 0.4 % of MWCNTs at different temperatures



## Practical part

### Investigation of Melt Flow Index of PBT/MWCNTs

1- After cutting the samples into small pieces, we checked the melt flow index of the PBT/MWCNTs mixtures using a melt flow index (MFI).

- It is used to measure the melt flow rate in grams that occurs in 10 minutes through a standard die.

2- We applied constant pressure to the melt by a piston and load a total mass of 2.160 kg at a temperature of 180 °C.

- we weighed the mass of the resulting flow.

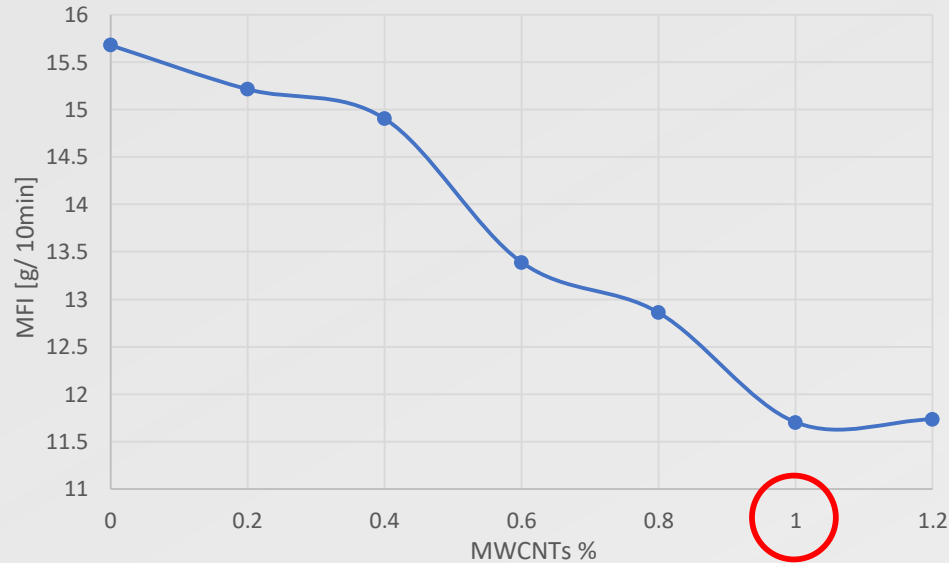
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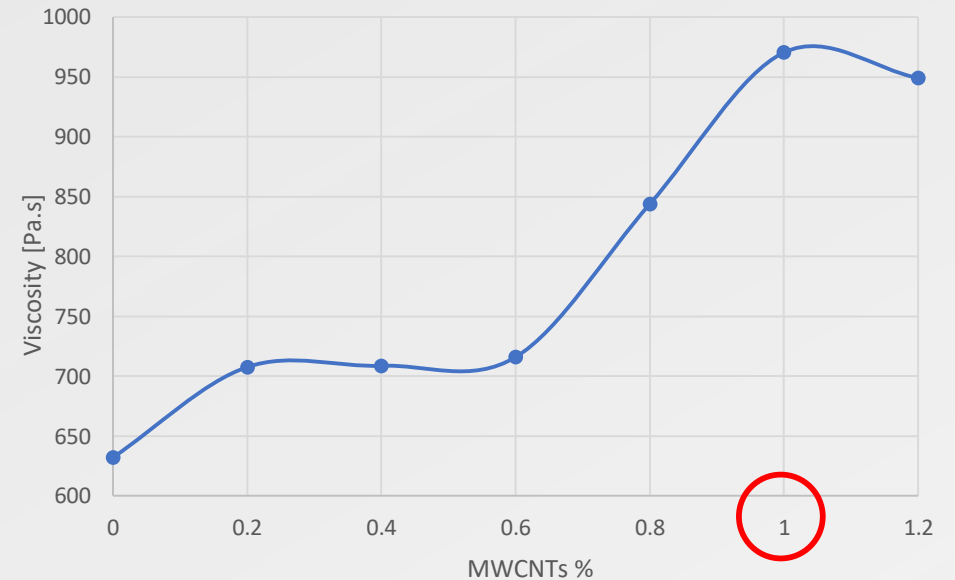


## The results

Where the results were as following



Melt flow index of PBT/MWCNTs.



Viscosity of PBT/MWCNTs

- The addition of MWCNTs led to a change in the properties of PBT/ MWCNTs → affected the processing method, fabrication and properties of the final product.



## Practical part

### Mixing ABS/PA6.6

1- After drying all materials overnight in an oven at 70 °C.

2- We mixed ABS/PA6.6 at the following ratios:  
60/40, 50/50, 80/20, 40/60,  
20/80 wt% by using a single-screw extruder connected to a mixer.

3- We cooled the extruded material with water and cut it into very small pieces.

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## Plans for the future

### We will do the following

- Calculation of activation energy of the isothermal crystallization of PBT/MWCNTs samples.
- Scan the samples by using scanning electron microscopy (SEM).
- Study the mechanical and electrical properties of PBT/MWCNTs.
- Study the mechanical and electrical properties of ABS/PA6.6.
- Mixing other ratios of ABS/ PA6.6 and adding MWCNTs to it.
- Study the effect of the addition of MWCNTs on the mechanical and electrical properties of the ABS/PA6.6 blend.
- Prepare new samples by adding polyethylene terephthalate (PET) with MWCNTs and studying their properties.





## Semester Activities

### Semester Activities

- I have finished writing two articles and waiting for the reviewers' decision to publish one of them.
  - **Title of the first article:** “A review on MWCNTs: the effect of its addition on the polymer matrix”.
  - **Title of the second article:** “Investigating the effect of adding multiwalled carbon nanotubes on the morphological properties of polybutylene terephthalate”.
  
- I have participated in two conferences,
  - Agteco: 24.11.2022
  - Óbuda “Fiatal Diplomások Fóruma 2022”: 10.12.2022
  
- I have taken the following courses:
  - " Polymeric nanocomposites " By Dr. Andrea Ádámne Major.
  - " Nanotechnology\_ chemical materials science". By Dr. Éva Kiss.

**THANK  
YOU  
FOR  
YOUR  
ATTENTION**

