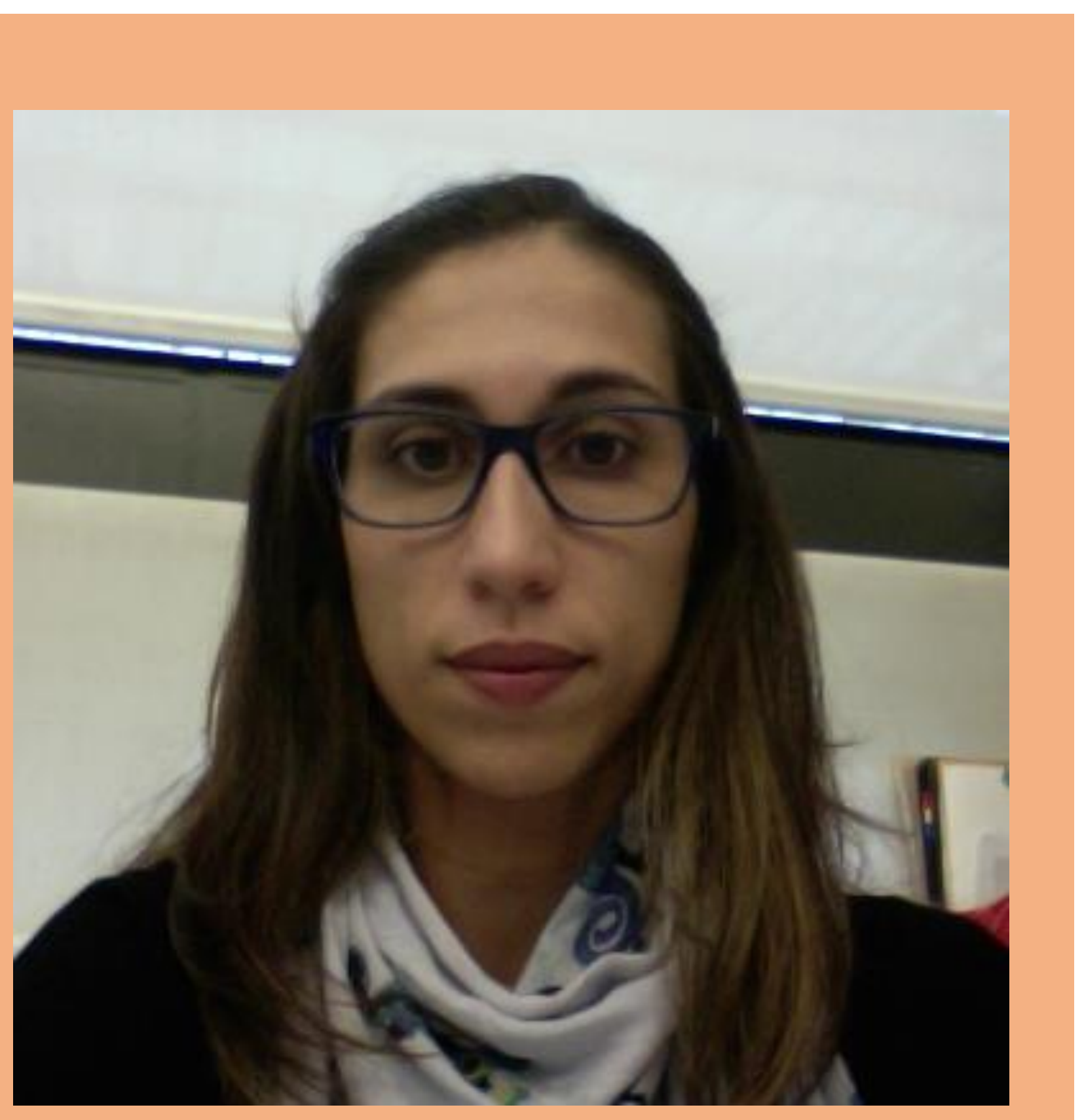
IPC – Institute for Polymers and Composites
University of Minho

Novel Organic Materials for Optoelectronics



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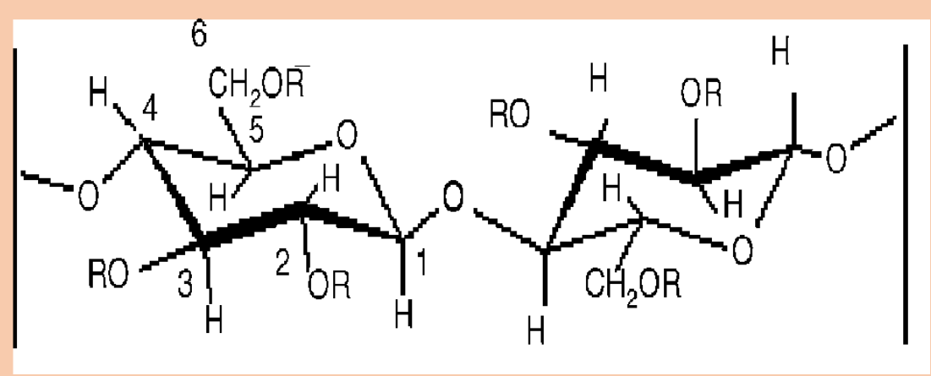
ENVIRONMENTLY FRIENDLY

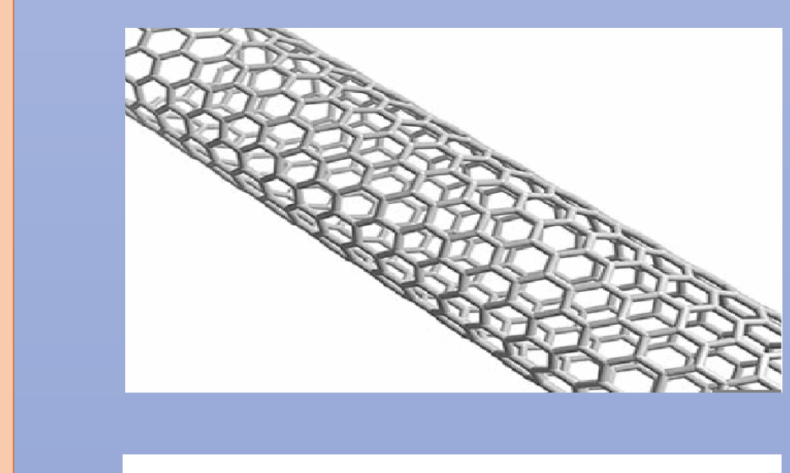
BIODEGRADABLE POLYMERS



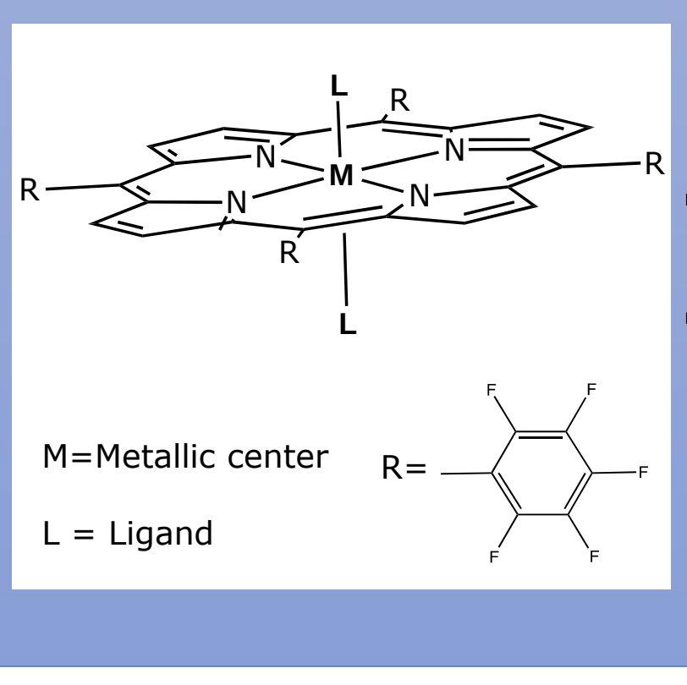
R = H or R =OCH_3

Cellulose Acetate

CONDUCTIVE ELEMENTS



CNT



M=Metallic center

L = Ligand

Porphyrin

NOVEL BIODEGRADABLE MATERIALS

Objectives

Nowadays the intensive use of polymeric materials raised environmental problems related with waste management. To solve this problem some strategies were adapted, but were not applied to high performance materials. Cellulose acetate (CA) is a biodegradable polymer and is an alternative to cellulose, which is difficult to process. But in order to develop novel biodegradable materials with optical/conductive properties, it is necessary to incorporate some specific compounds into the biodegradable matrix. These compounds should allow to conduct electricity, as carbon nanotubes and porphyrins. The last ones are intensely coloured and have also interesting optical properties. Therefore the main objectives of this work is to prepare materials based in cellulose acetate with optical/conductive properties by preferably a green approach in order to obtain environmental friendly materials.

Methods and techniques

Methods:

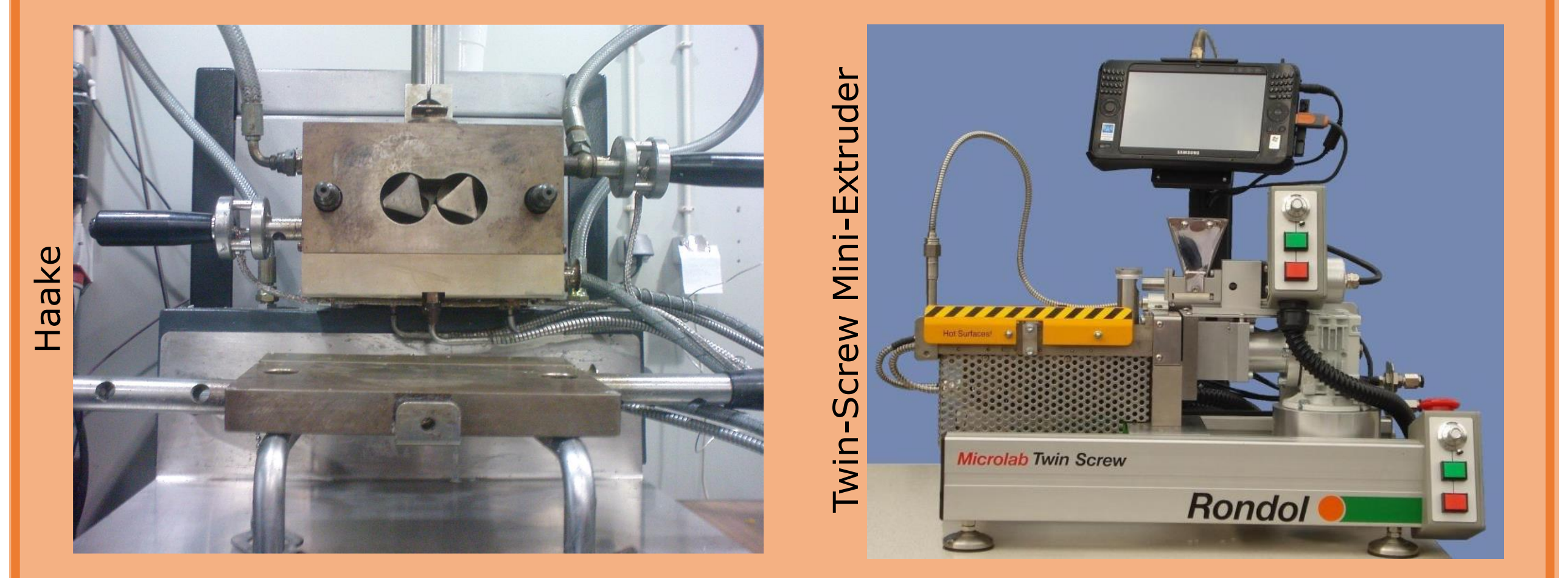
1st) Chemical modification of carbon nanotubes surface and porphyrins;

2nd) Incorporation of the carbon nanotubes and porphyrins into the cellulose acetate matrix, and processing by melt mixing in an intensive mixer Haake and in a twin-screw extruder and also by electrospinning (Figure 1).

Techniques:

^{1}H and ^{13}C RMN, FT-IR spectroscopy, UV-visible spectroscopy, ESI-MS, thermal gravimetric analysis (TGA), differential scanning calorimetry (DSC), gel permeation chromatography (GPC), transmission microscopy, scanning electron microscopy (SEM), rotational rheometry, current-voltage characteristics.

MELT MIXING



ELECTROSPINNING

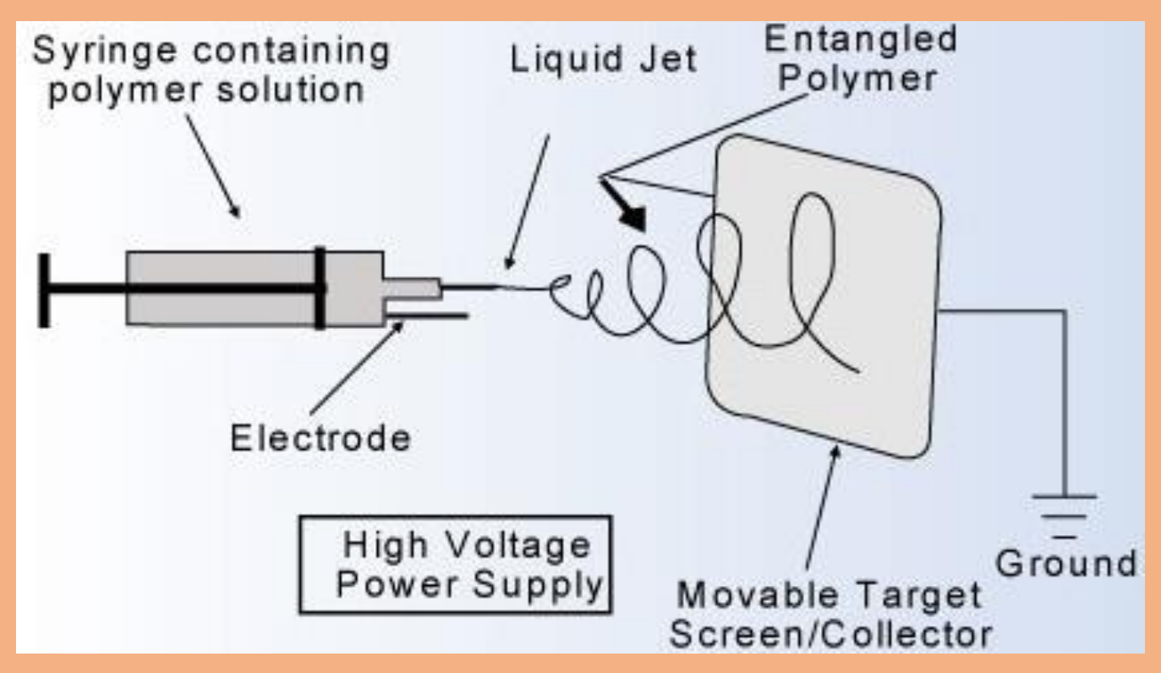
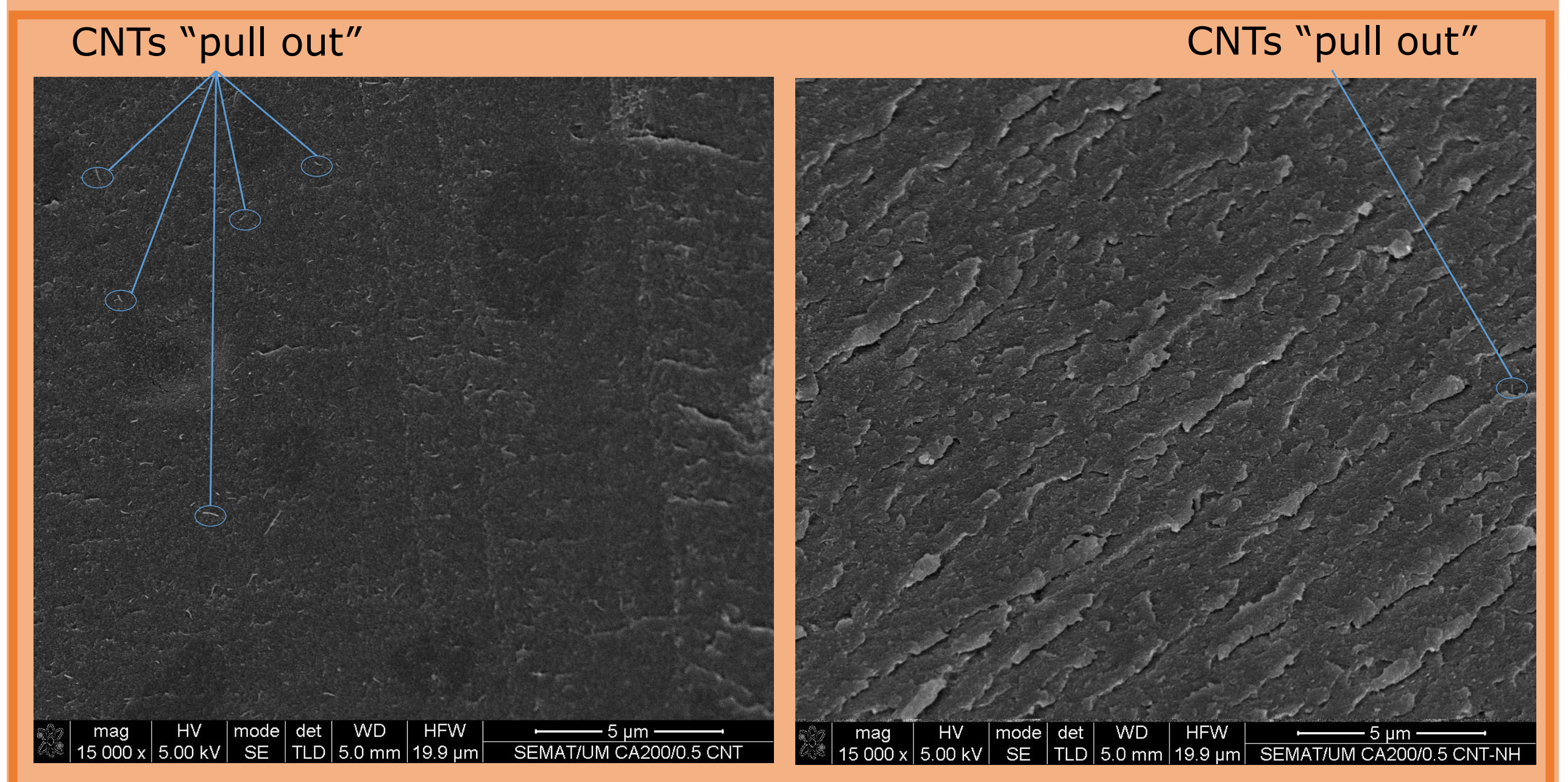


Figure 1



CA with Neat CNTs

CA with Functionalized CNTs

Figure 2

Results

- Even though CA chain scission was observed during processing by melt mixing, the thermal stability of the nanocomposites with CNTs was enhanced due to insipient crystallization;
- The thermal stability enhancement was more pronounced for the extruder nanocomposites;
- The CNTs functionalization did not show a significant effect on the thermal properties but it showed a great influence in the affinity between CA/CNTs and in the CNTs dispersion;
- Functionalized CNTs showed a greater affinity with the CA, i.e., less "pull out" (Figure 2), which difficult the dispersion and promoted the formation of more and larger agglomerates when compared with the neat CNTs;
- The samples prepared with 0.5 wt% of neat and functionalized CNTs showed a typical plateau on the storage modulus (Pa) vs frequency (Hz) curves (Figure 3) related to the achievement of rheological percolation, but only the first also achieved electrical percolation (electrical resistivity = 2.5 x10^5 Ω.m) (Figure 4).

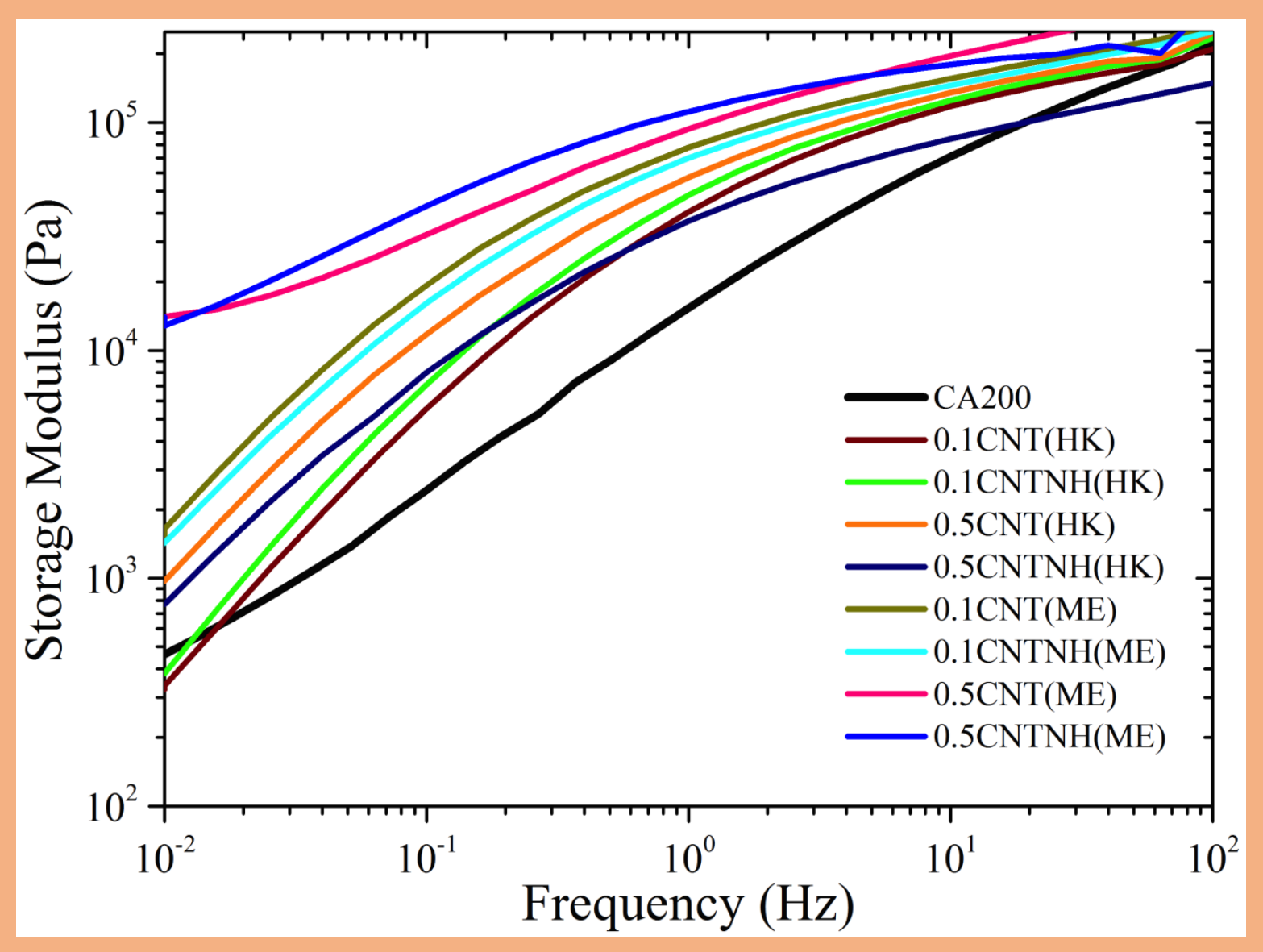


Figure 3

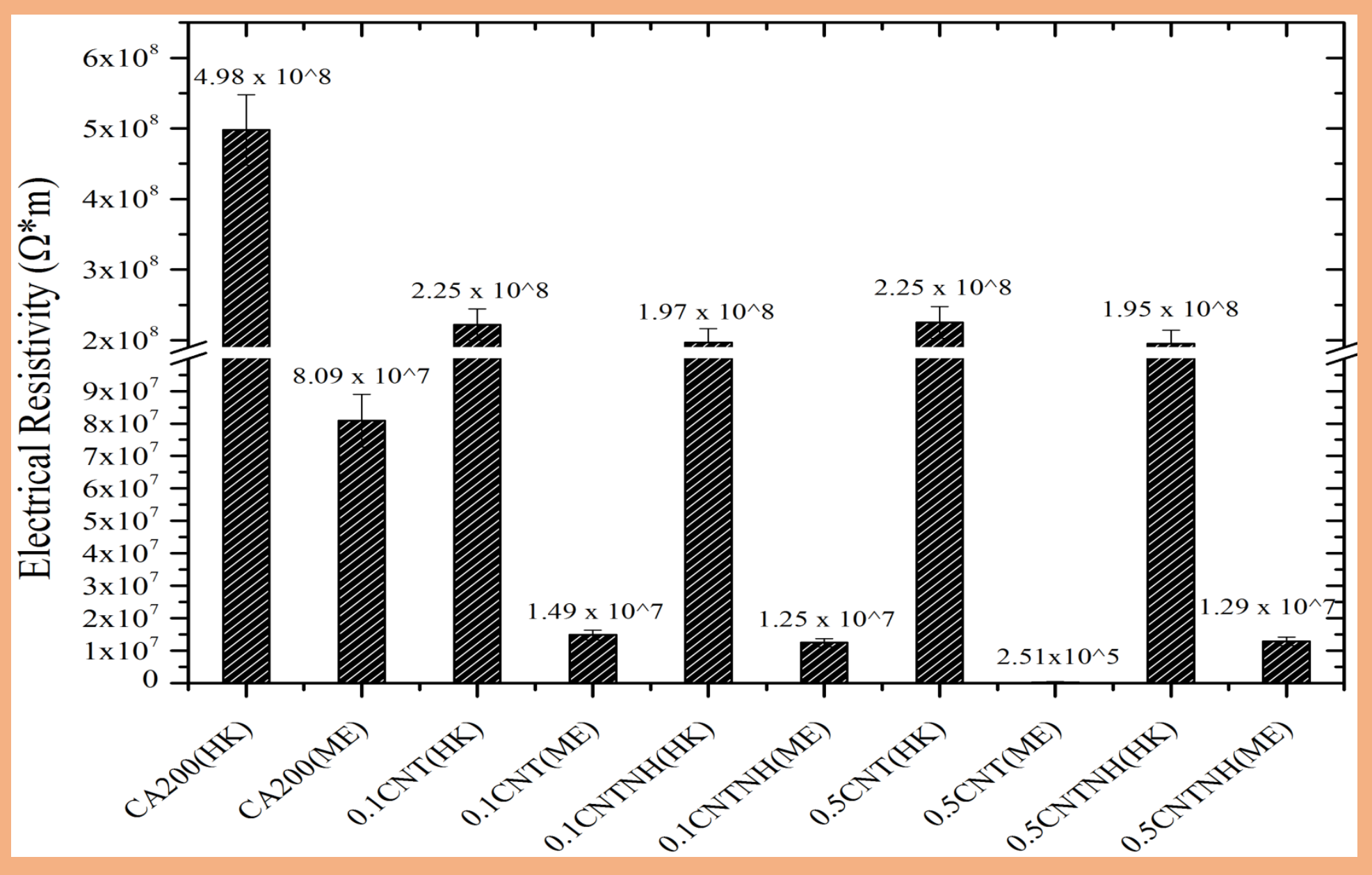


Figure 4

Publications

Delgado-Lima, A, Paiva, M.C., Machado, A.V. Cellulose Acetate/Carbon Nanotubes Nanocomposites by Melt Mixing: Polymer Structure and Thermal Stability. Carbohydrate Polymers (submitted).

Delgado-Lima, A, Paiva, M.C., Machado, A.V. Cellulose Acetate/Carbon Nanotubes Nanocomposites by Melt Mixing: Morphology and Electrical Conductivity. Carbohydrate Polymers (submitted)

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Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR
SFRH/BD/81711/2011

Universidade do Minho