# Magnetic and wave absorption properties of carbon-based core-shell nanostructured materials

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## Motivation

Lots of metal-carbon nanostructured materials with metallic core/carbon shell nanoparticles were studied due to a wide range of applications in innovative areas of energy, biotechnology, etc [1, 2]. Among them systems with nickel core [1, 3] and cobalt core [2]. Such structures are presented as effective novel carbon adsorbents which work for the removal of organic contaminants [4].

## The aim

The aim of this work was to investigate the effect of carbon-coated nickel and cobalt nanoparticles as filler on magnetic and wave absorption properties of epoxy composites (CMs) in 40-60 GHz frequency range.

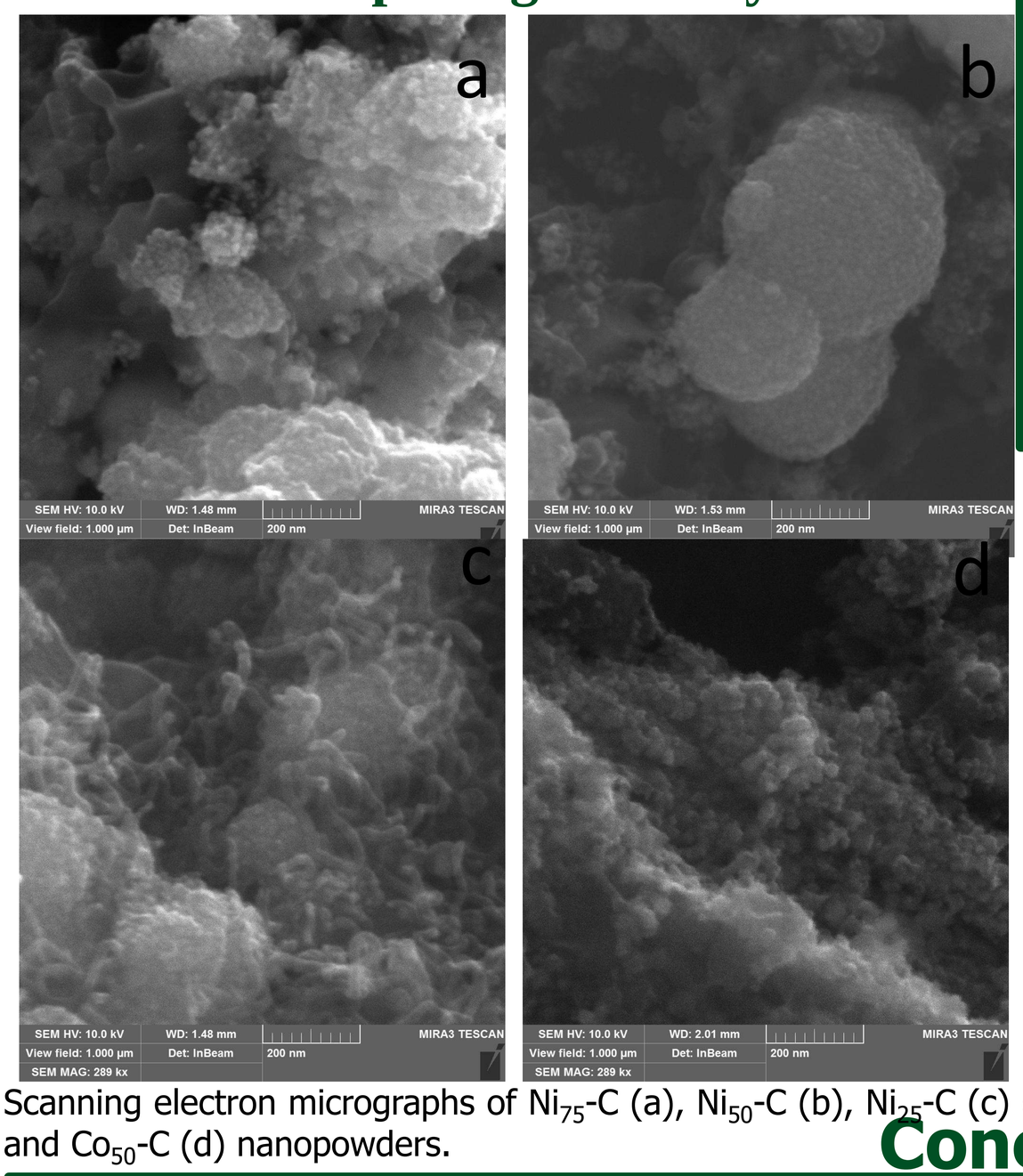
## Object

Nanocarbon-metal $Ni_x$-C and $Co_{50}$-C core-shell structures were synthesized using mechanochemical method in combination with pyrolysis at 800 °C: $Ni_{25}$-C, $Ni_{50}$-C, $Ni_{75}$-C and $Co_{50}$-C .
Epoxy resin (L285) was chosen as polymer matrix.
The bulk composite specimens were prepared by mixing of 3-20 wt. % nanocarbon-metal $Ni_x$-C and $Co_{50}$-C core-shell structures with epoxy.

## Research method

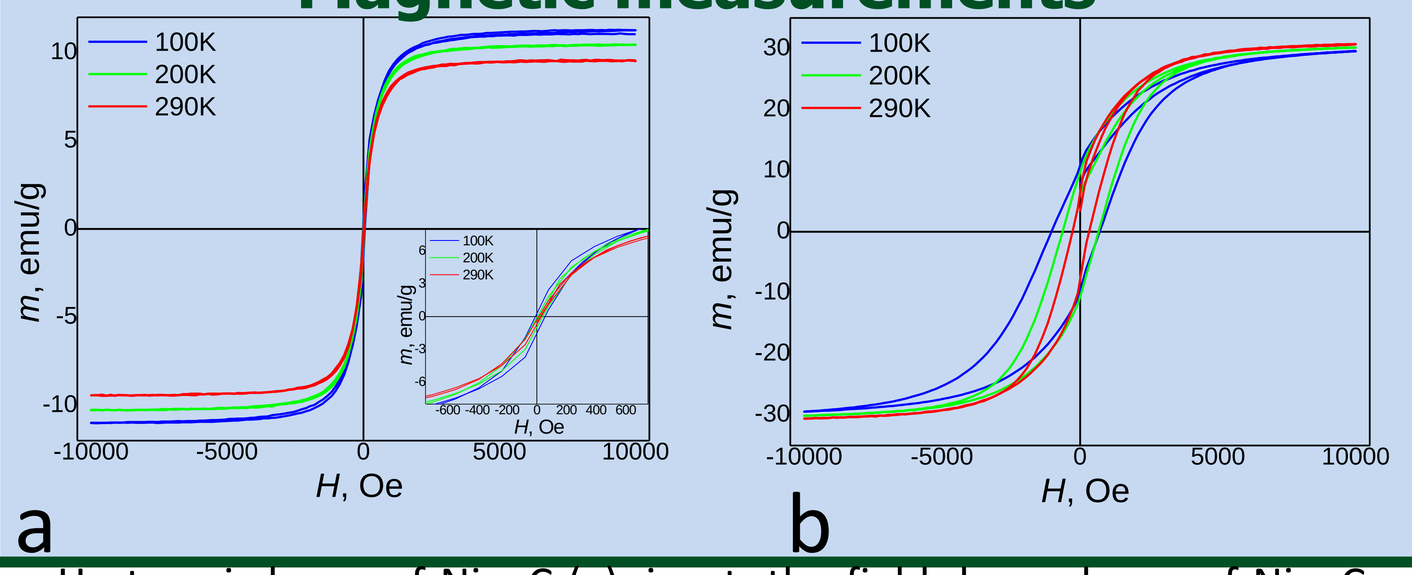
•Scanning electron microscopy;
•Vector panorama Agilent Technologies N5227A-200 was used for measurements of frequency dependencies of complex permittivity of CMs at room temperature.
•The magnetic hysteresis loops were investigated by using a vibrating sample magnetometer (LDJ-9500, LDJ Electronics, Troy, MI 48099, USA) with a maximum magnetic field of 10 kOe. The magnetization curves were measured at the temperature range 100-290 K.

## Morphological study



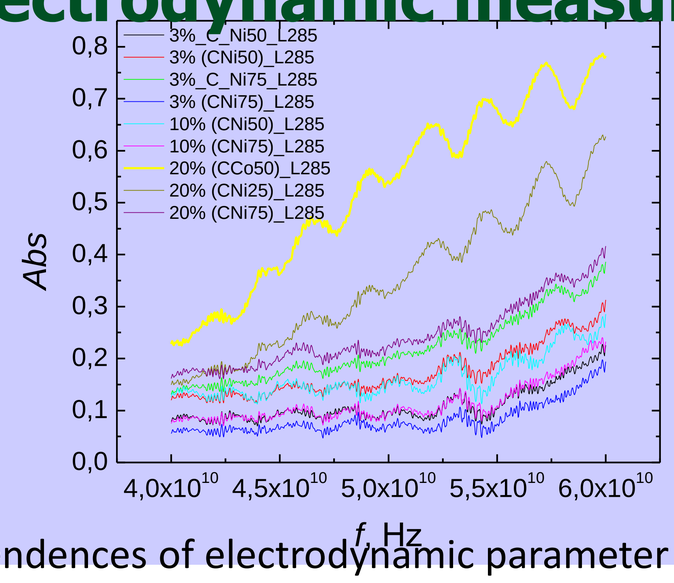

Scanning electron micrographs of $Ni_{75}$-C (a), $Ni_{50}$-C (b), $Ni_{25}$-C (c) composites of thickness of 1 mm with the content of fillers 3 wt. %-20 wt. % and $Co_{50}$-C (d) nanopowders.

## Magnetic measurements




Hysteresis loops of $Ni_{25}$-C (a), inset: the field dependence of $Ni_{25}$-C around zero-point; $Co_{50}$-C (b) core-shell structures.

## Electrodynamic measurements




Frequency dependences of electrodynamic parameter SEA of Co-C, $Ni_x$-C epoxy

## Conclusions

A number of the nanocarbon-metal $Ni_x$-C and $Co_{50}$-C core-shell structures were obtained from phenol-formaldehyde resin as a carbon precursor using a mechanochemical method and pyrolysis at 800 °C. The morphology of the obtained core-shell structures was characterized by SEM. The magnetic investigations were provided for pure carbon-coated nickel and cobalt powder. The work presents the results of investigations of the effect of carbon-coated nickel and cobalt nanoparticles ($Ni_{75}$-C, $Ni_{50}$-C, $Ni_{25}$-C and $Co_{50}$-C) as filler on wave absorption properties of epoxy CMs. Wave absorption properties of the composite materials have been studied in a wide frequency range: 40-60 GHz. It was found that morphology and composition (the content of the metal phase and its relation to the carbon phase) of $Ni_x$-C core-shell structures embedded in epoxy matrix influences on the wave absorption characteristics of CMs.

## References

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