UPEC
UNIVERSITÉ PARIS-EST CRÉTEIL VAL DE MARNE
Connaissance - Action

PROPRIETES THERMIQUES ET ELECTRIQUES DES NANO ET MICROCOMPOSITES

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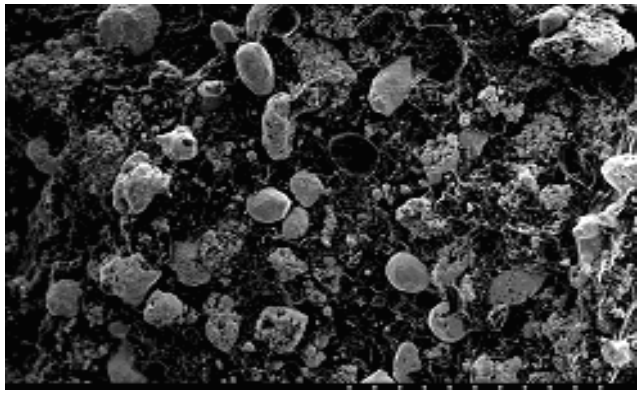
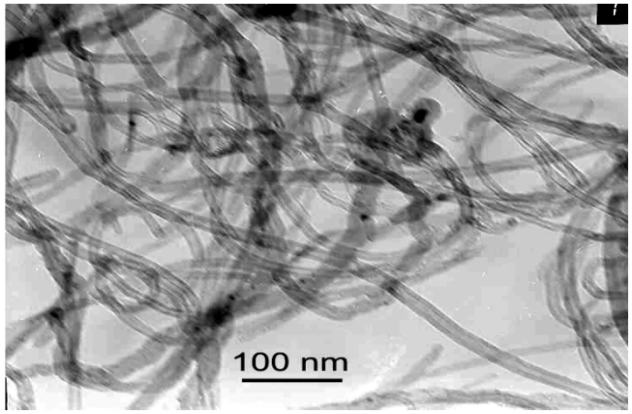
Composites polymères/charges conductrices

Charges conductrices

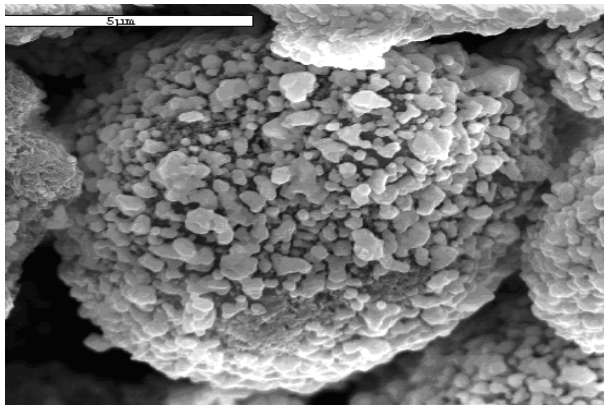


PP/Cu

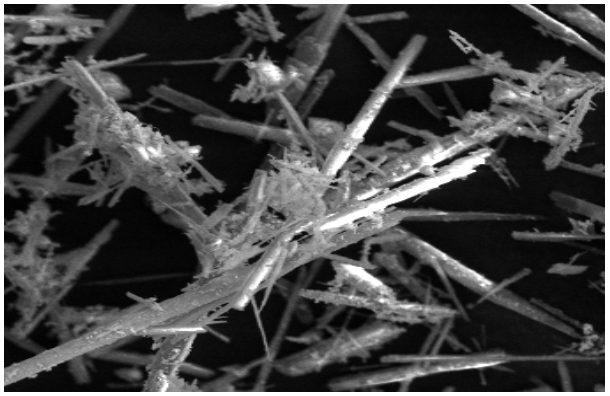


PVC/MWCNT

Charges isolantes métallisées



EVA/Wollastonite-Ag

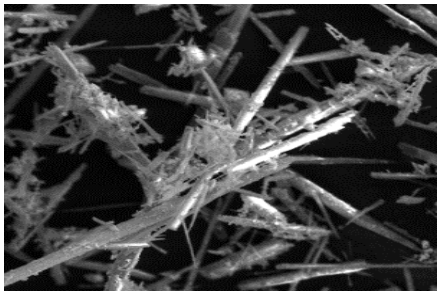


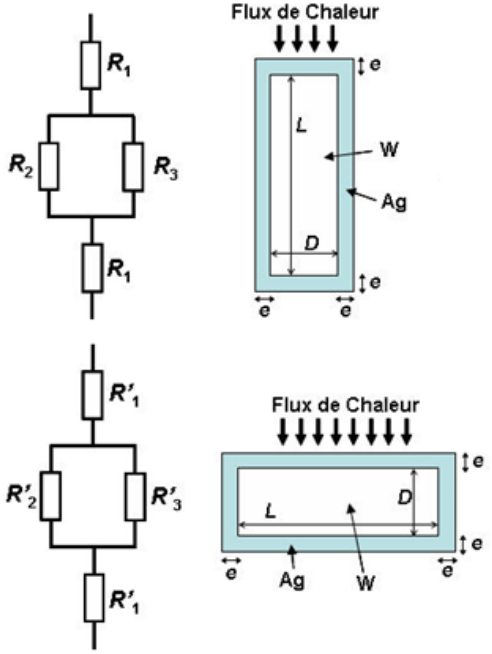
HDPE/PA-Ag

Composites polymères/charges conductrices

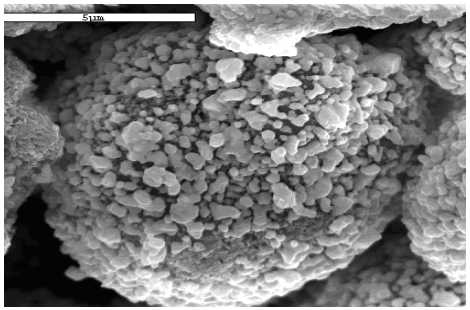
Modélisation λ de la charge

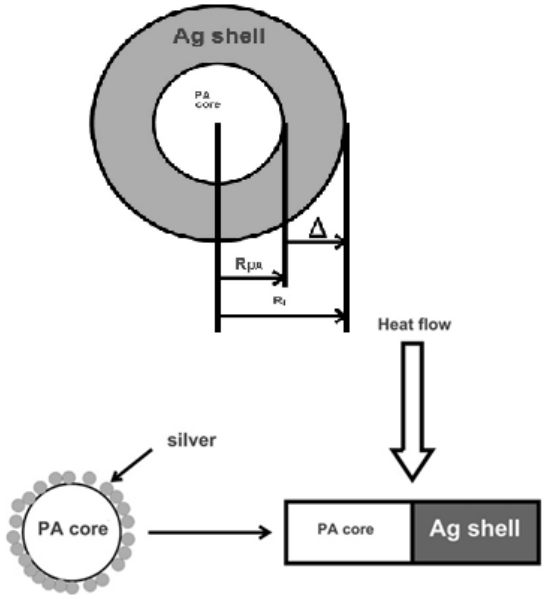
EVA/Wollastonite-Ag





HDPE/PA-Ag

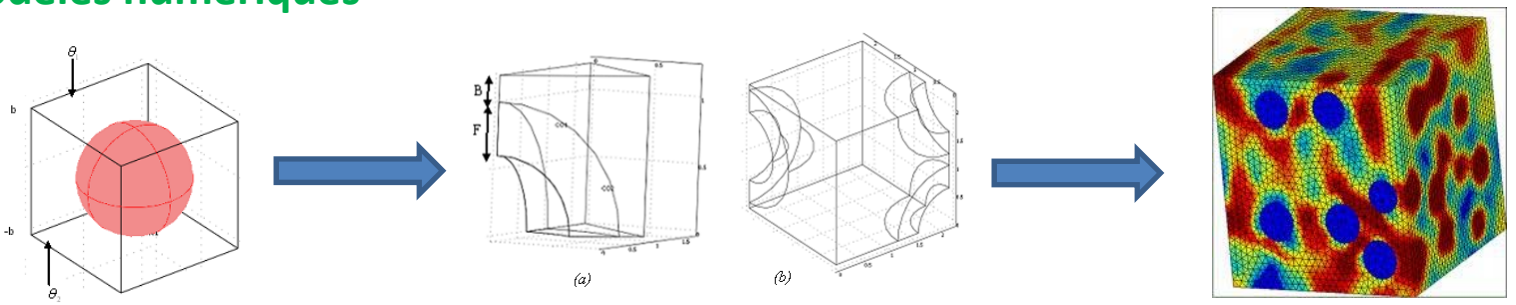




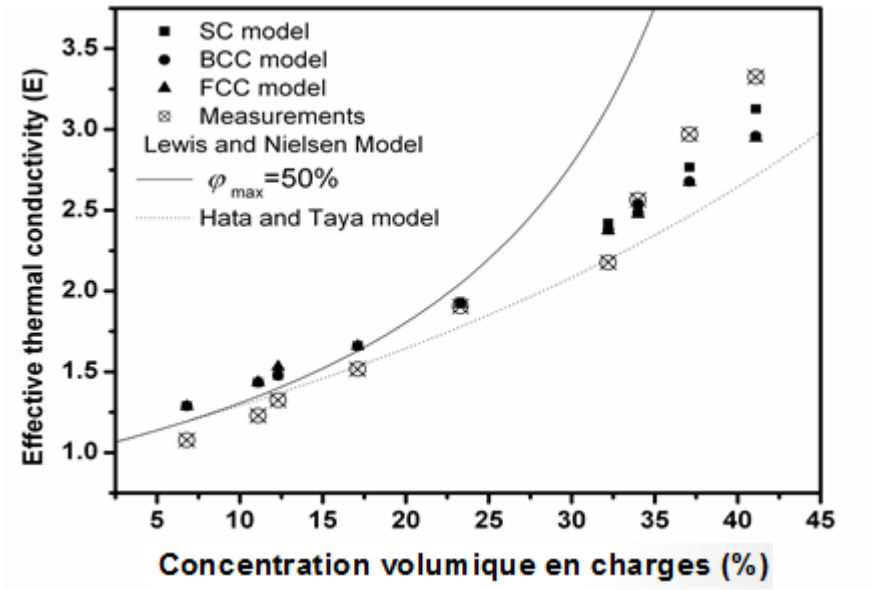
Composites polymères/charges conductrices

Modélisation λ des composites

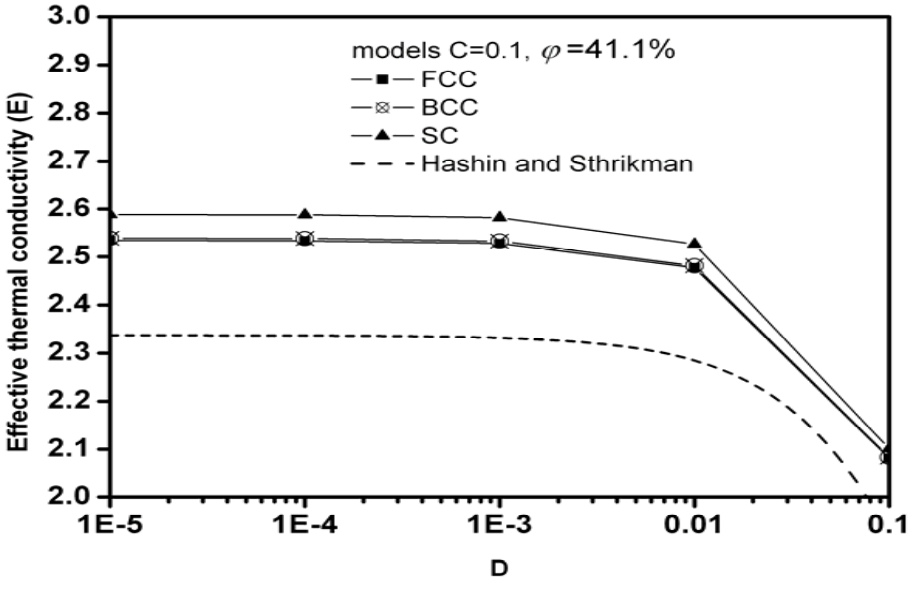
Modèles numériques



Effet de la concentration en charges



Effet de la résistance de contact



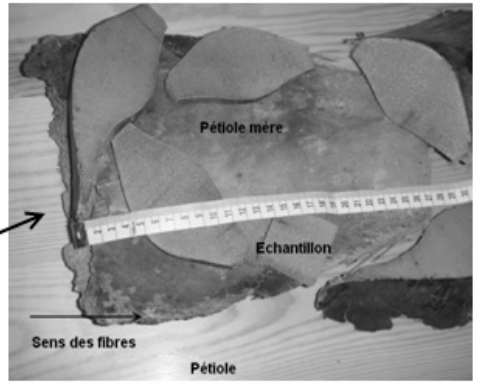
Biocomposites et matériaux à base de fibres naturelles

Composites à matrices polymères/fibres naturelles

Fibres: Ananas, Banane, Sisal, …

Biocomposites et matériaux à base de fibres naturelles

Composites à matrices minérales/fibres naturelles



Grapp

FPD: Fibres de Palmier Dattier

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Optimisation des propriétés thermophysiques et électriques des composites à matrice polymère par application d'un champ magnétique

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France

Polymers are materials with low value of thermal conductivity

$0.15 \leq k \leq 0.5$ [$Wm^{-1}K^{-1}$]

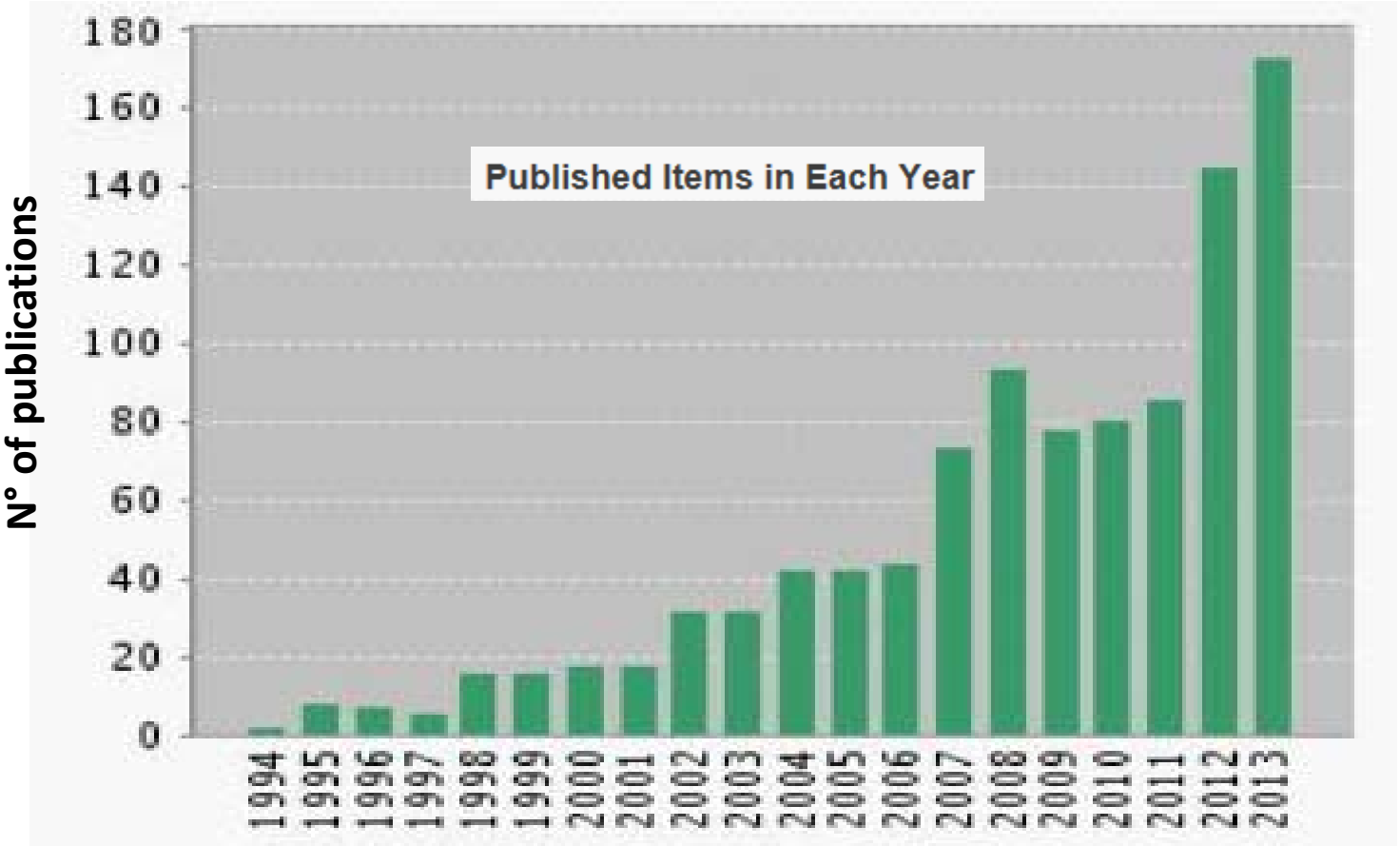
Increase thermal properties for industrial applications

Combine polymeric matrix with conductive fillers

Develop new materials with properties adapted to specific applications

Polymer Composites with conductive fillers: Bibliographic Statistics

Source: Web of Knowledge (Thomson Reuters 2014)



Aims

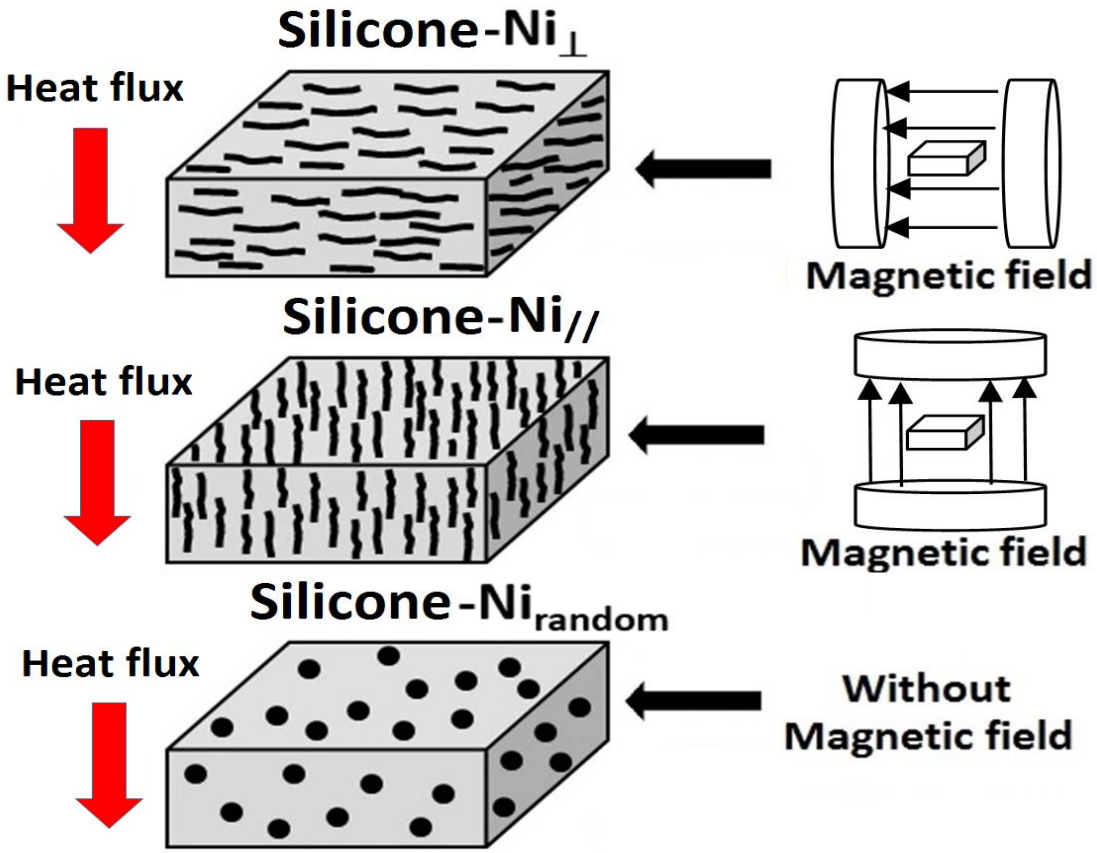
How optimize the conductive properties of polymer composite materials?

Use an electric and magnetic field during the preparation of the composites

Samples preparation

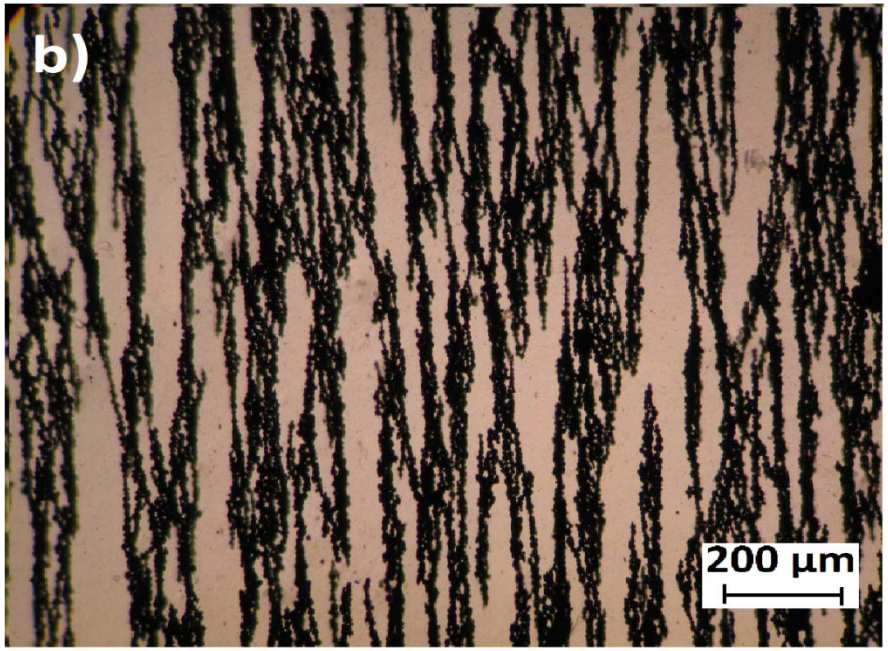
Matrix: Silicone Rubber
Fillers: Ni (10µm)

From 0 to 35% vol. Ni → in Silicone Rubber Matrix

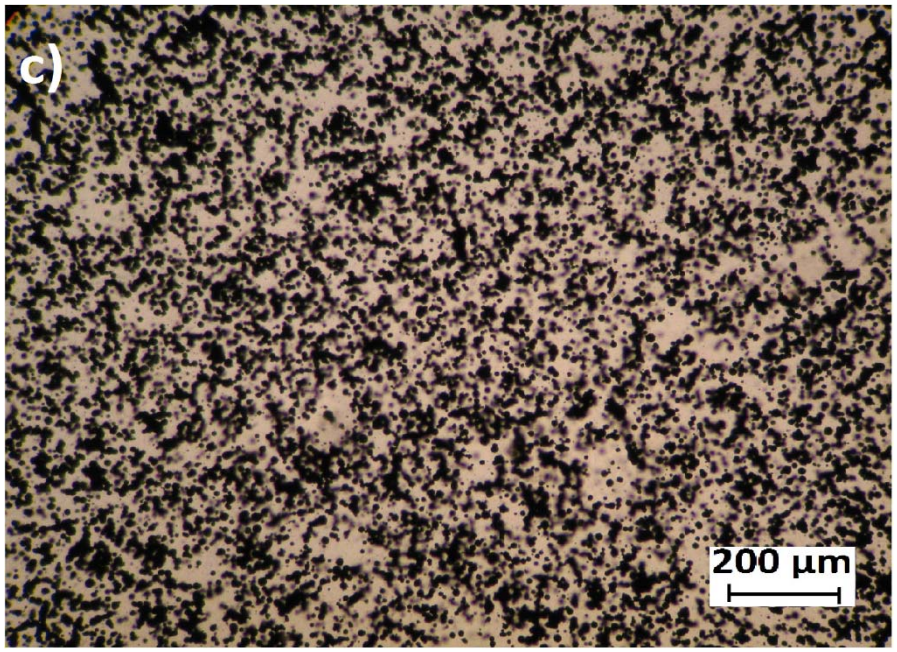


Micrograph structure

Matrix: Silicone Rubber
Fillers: Ni (10µm)



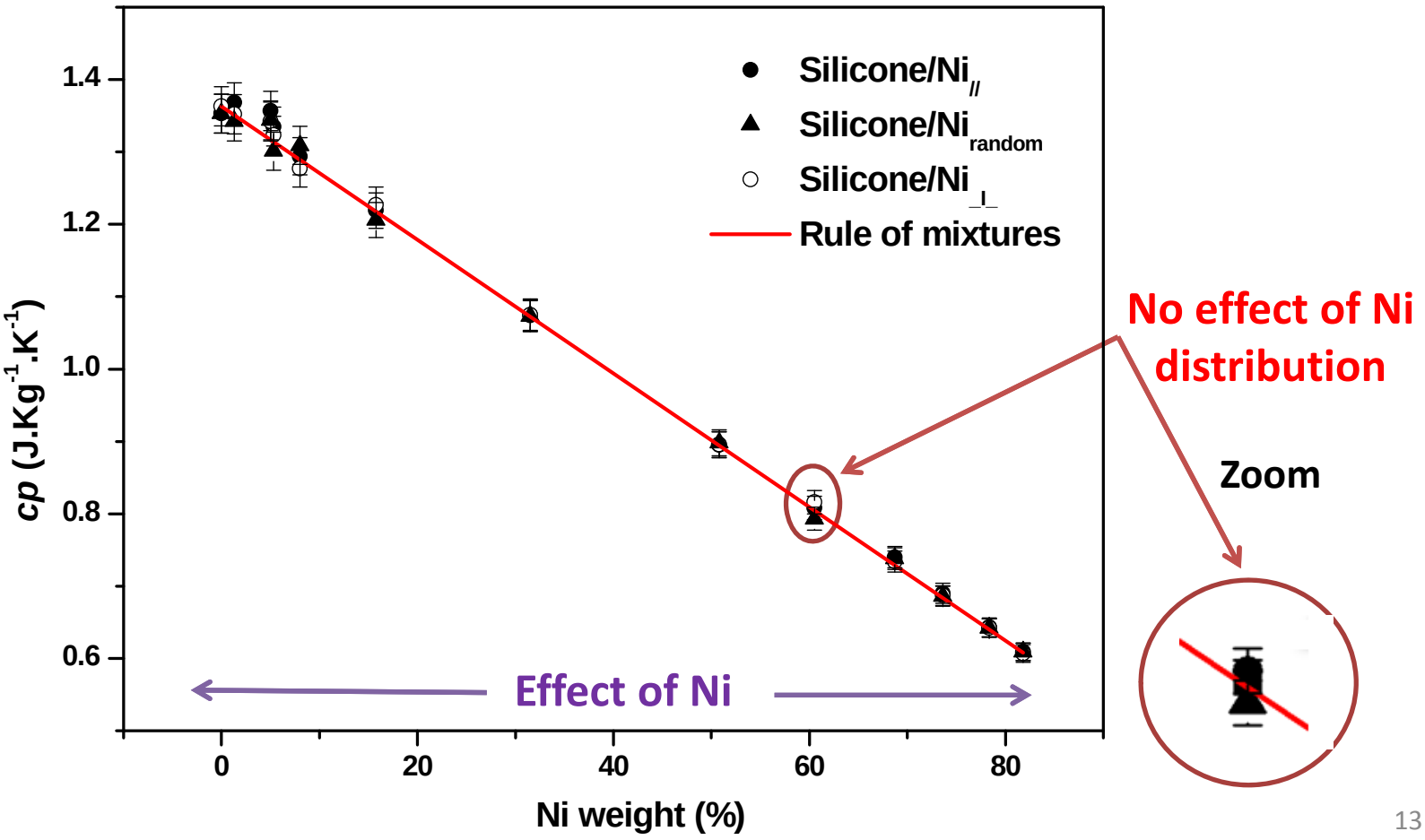
With magnetic field



Without magnetic field

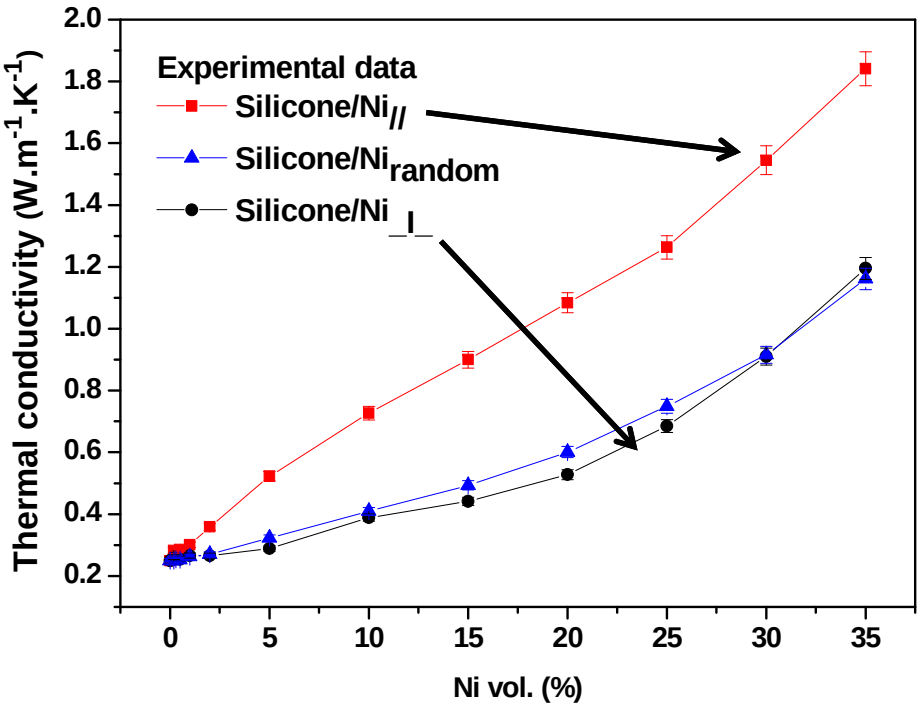
Thermophysical behavior

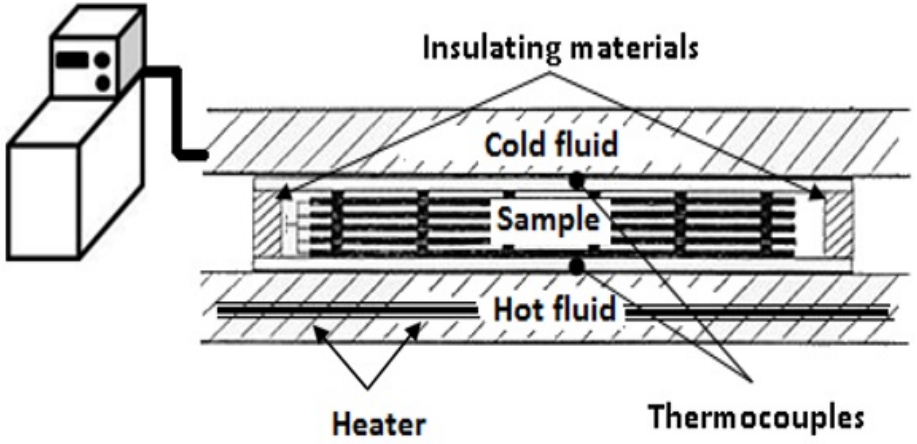
Specific heat capacity



Thermophysical behavior

Thermal Conductivity

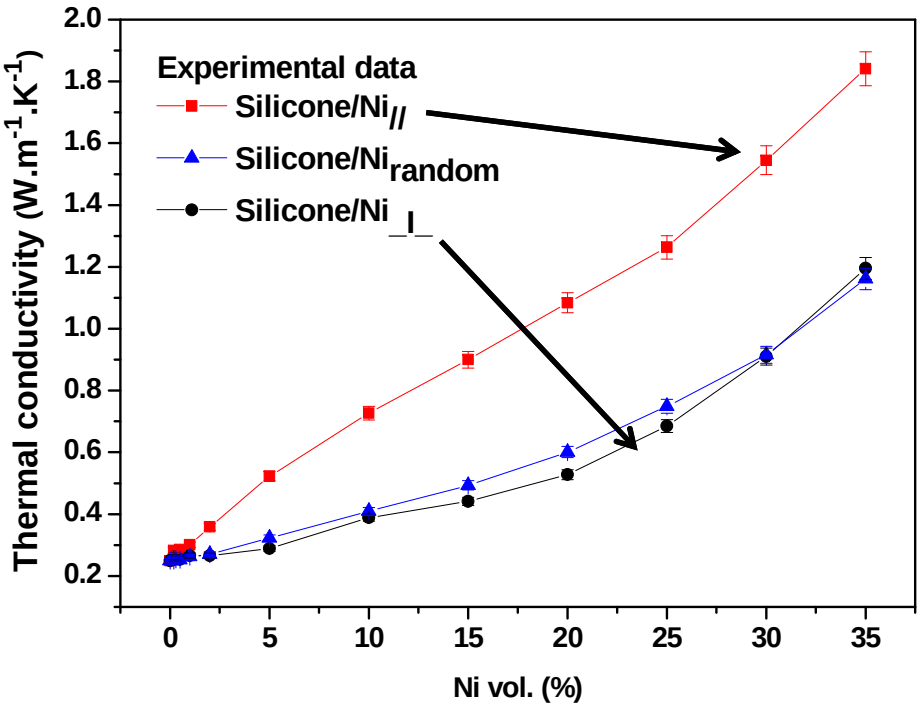




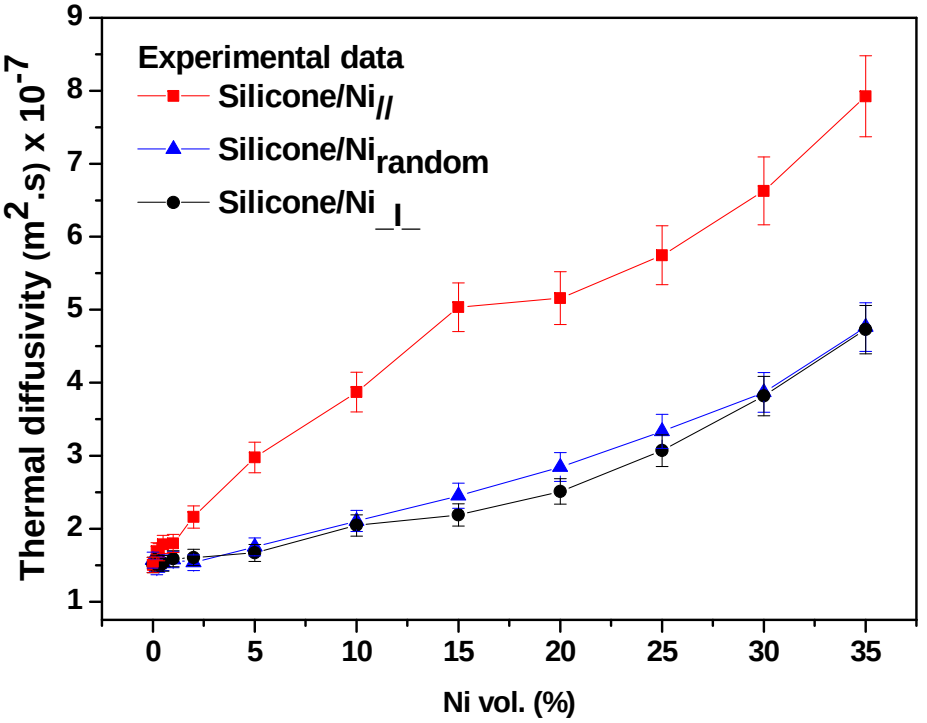
Thermal conductivity experimental setup based on (HGP) method

Thermophysical behavior

Thermal Conductivity



Thermal diffusivity



- ❑ Effect of Ni vol. (%)
- ❑ Effect of Ni distribution
- ❑ Same behavior (thermal conductivity and diffusivity)

Thermophysical behavior

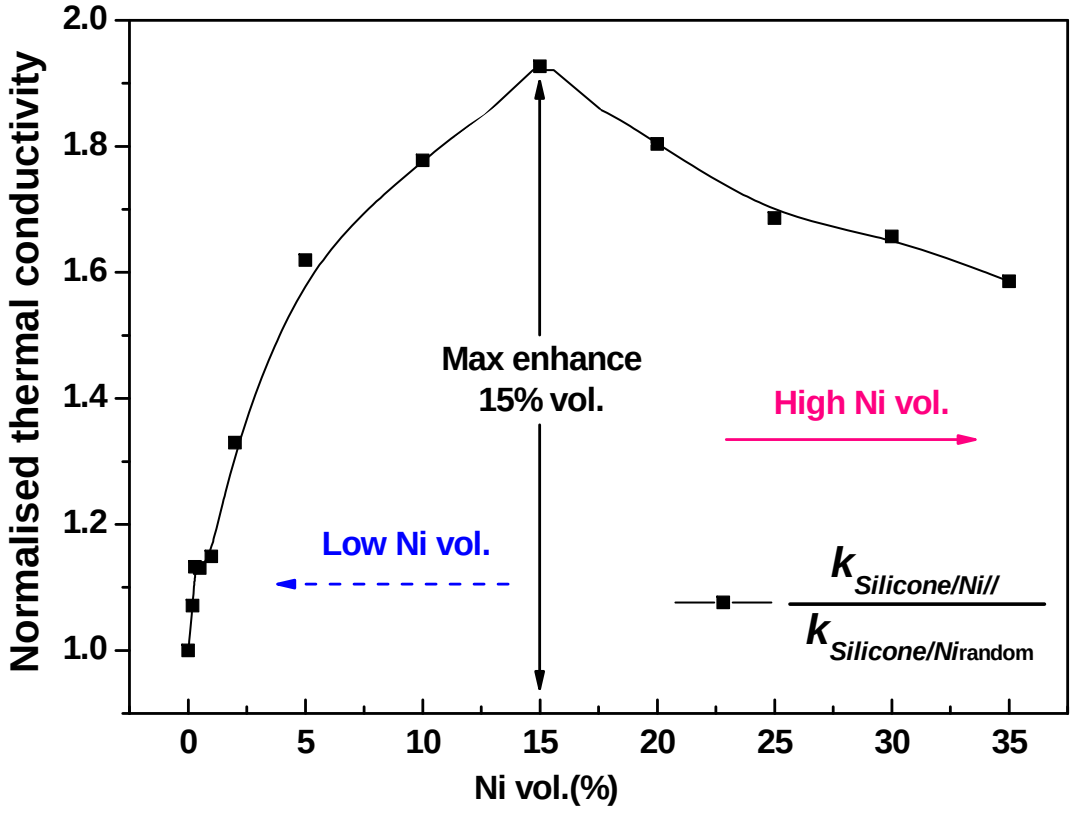
Thermal Conductivity

Low Ni vol. ➔ Poor chain-like structure without magnetic field

High spatial anisotropy

High Ni vol. ➔ Spatial distribution of Ni tends to be almost the same

Less effect of magnetic field



Thermophysical behavior

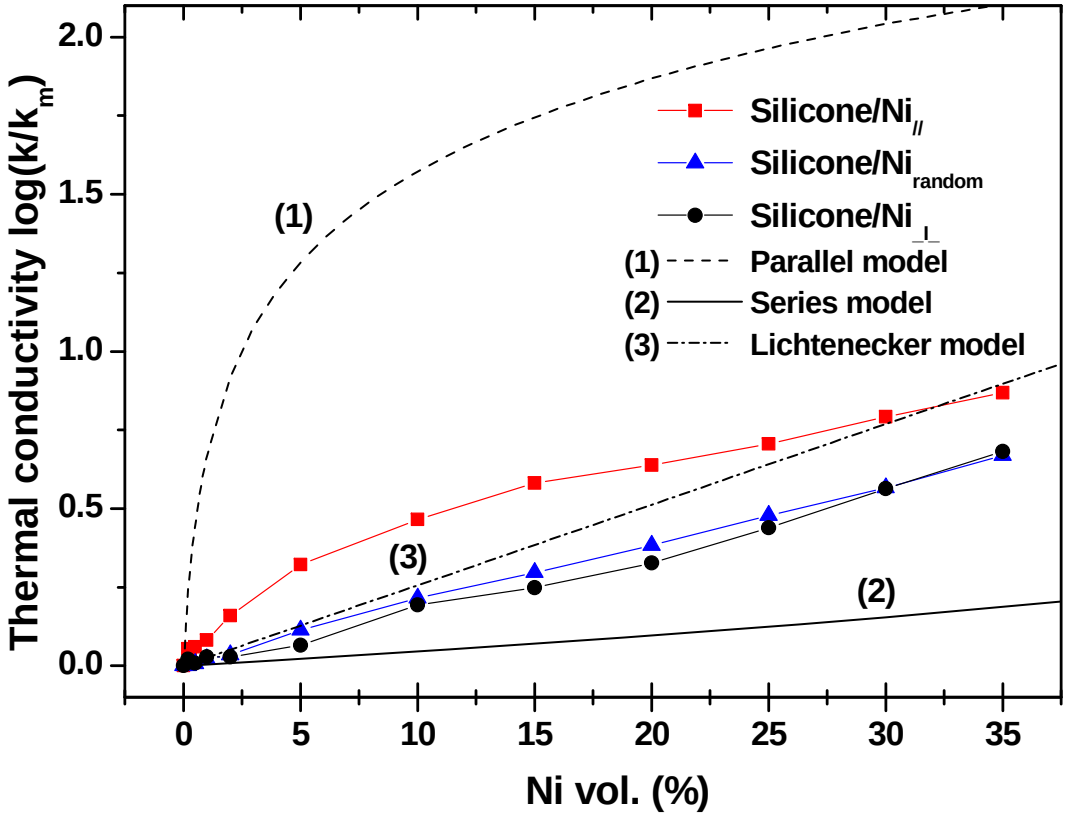
Thermal Conductivity models

Lichtenecker's model

Agreement with measured values (⊥, random) until 10 % vol.

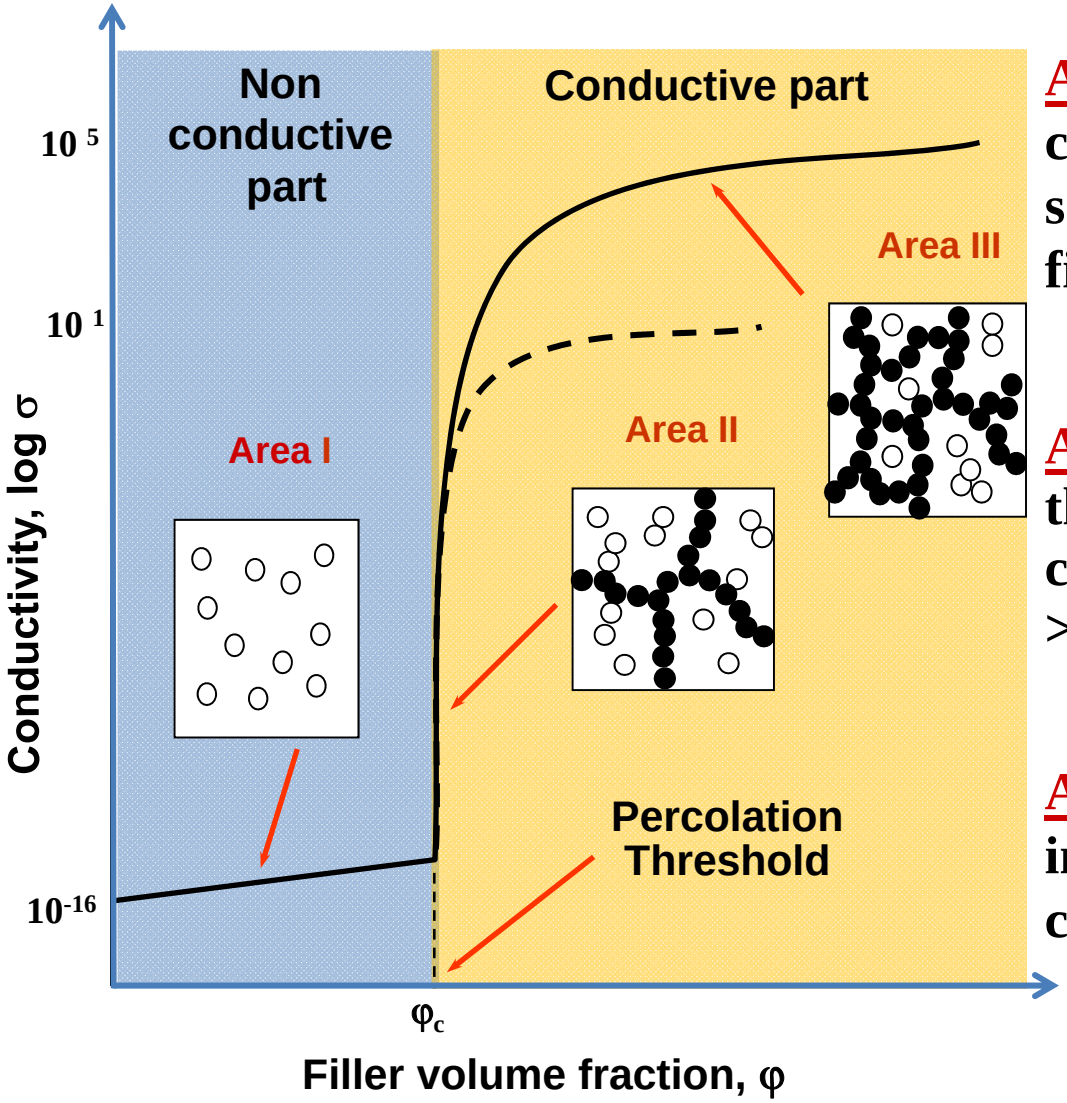
$Ni_{//}$ > 25%vol.

experimental values approximate Lichtenecker's model



❖ **Structure effect with gradual reduction of λ when Ni increase**

Electrical behavior



Area I – the composite is non-conductive, the matrix includes the separate particles of conductive filler.

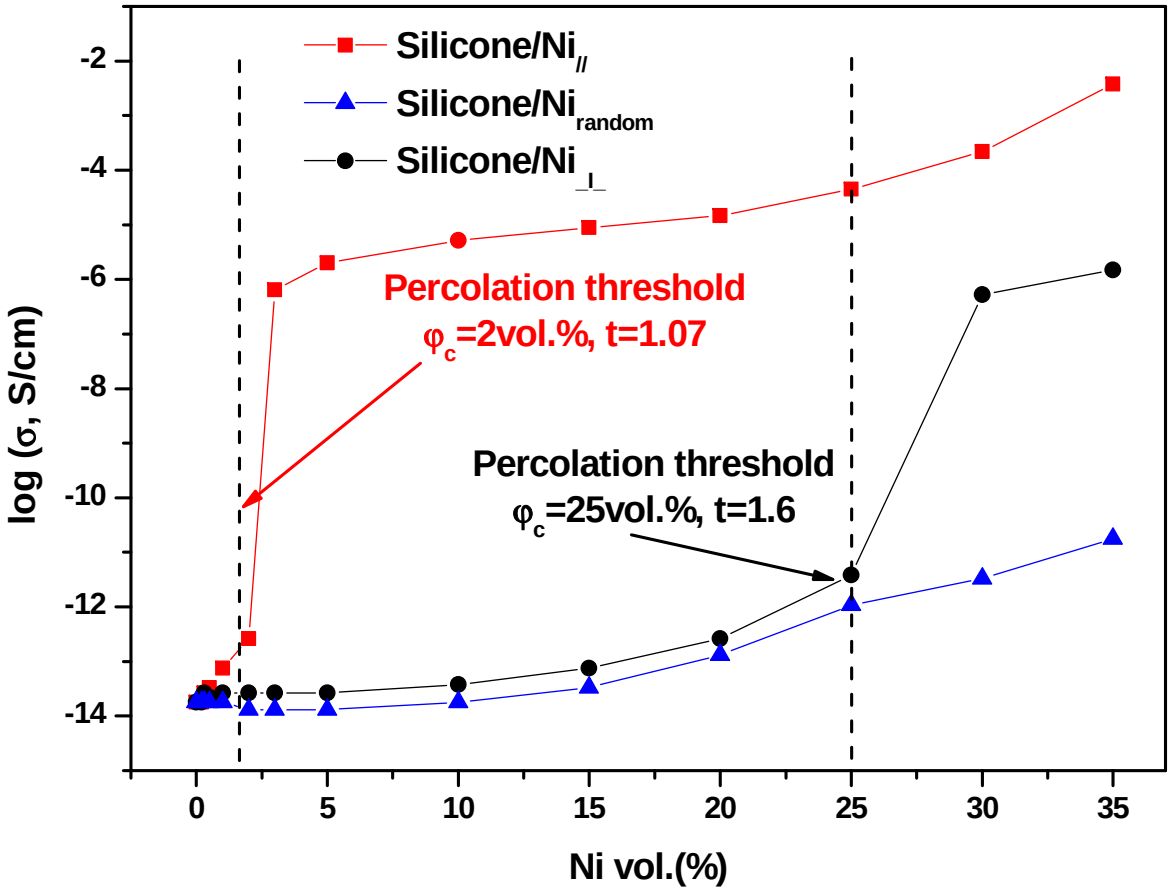
Area II – the region of percola-tion, the conductive cluster is created, the conductivity sharply increases at $\varphi > \varphi_c$.

Area III – the conductivity slowly increases because of growth of conductive cluster.

Electrical behavior

Electrical Conductivity

- ❑ Effect of Ni
- ❑ Effect of Ni distribution



Conclusion

- Combination of polymers with conductive fillers allows an increasing of both thermal and electrical properties
- Effect of Ni content on λ, α, cp and σ
- Effect of Ni distribution (orientation) on λ, α, and σ
- Use of a magnetic field during the preparation of the composites → enhancement of the conductivities (λ, σ) and α

Thank you