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Study of the mechanical properties of polymers reinforced with nanoparticles of adjustable size, shape and surface chemistry

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Study of the mechanical properties of polymers reinforced with nanoparticles of adjustable size, shape and surface chemistry

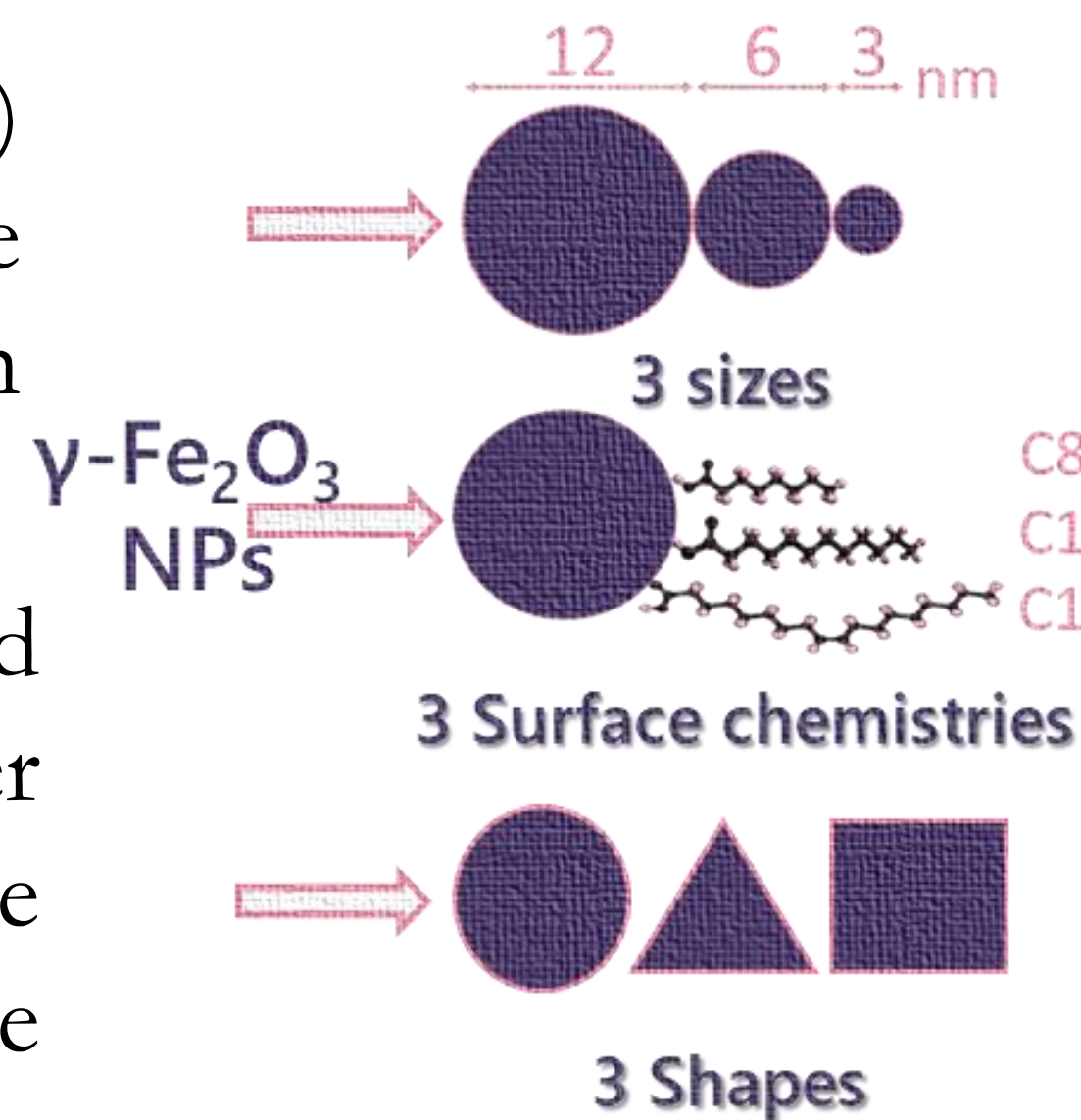
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Context & Objectif

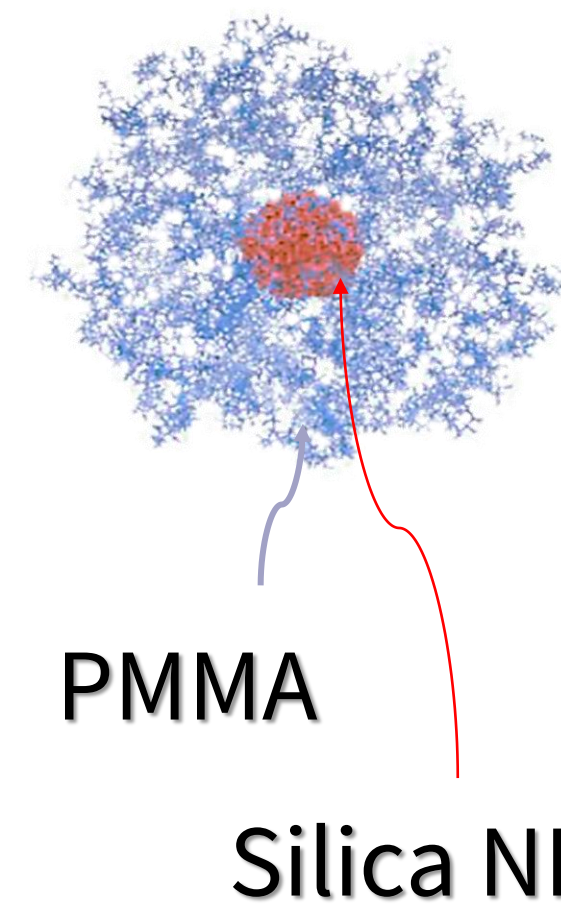
To Investigate the effects of size, surface chemistry and morphology of iron oxide nanofillers on the mechanical and thermal properties of nanoreinforced polymers:

1. Ligand-coated maghemite ($\gamma\text{-Fe}_2\text{O}_3$) nanoparticles are synthesized by the thermal decomposition of an organometallic precursor.
2. Growth mechanisms are investigated through the effect of each key parameter (mentioned in the next section) on the nanoparticle characteristics (size, surface chemistry, morphology).
3. The aim is to synthesize tunable (1) sizes, (2) shapes and (3) surface chemistries.



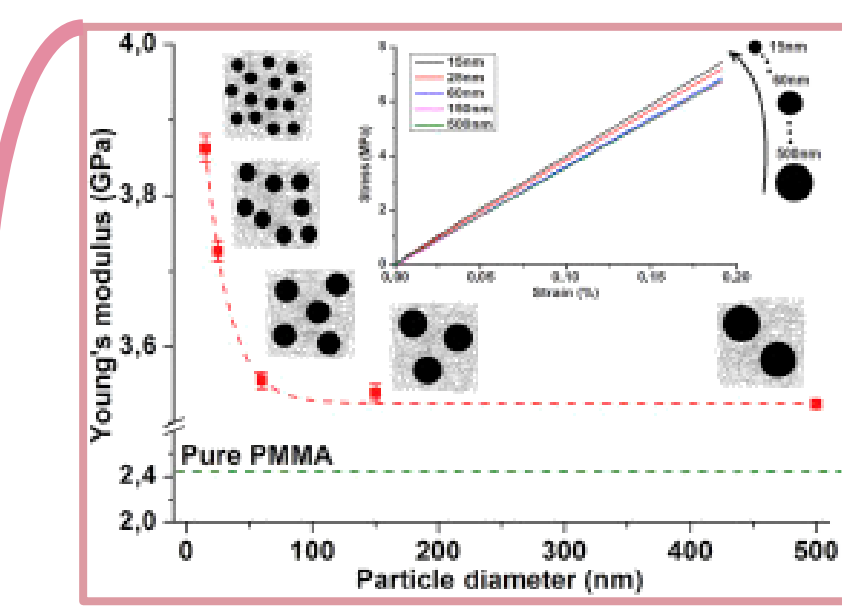
Previous studies

Material studied

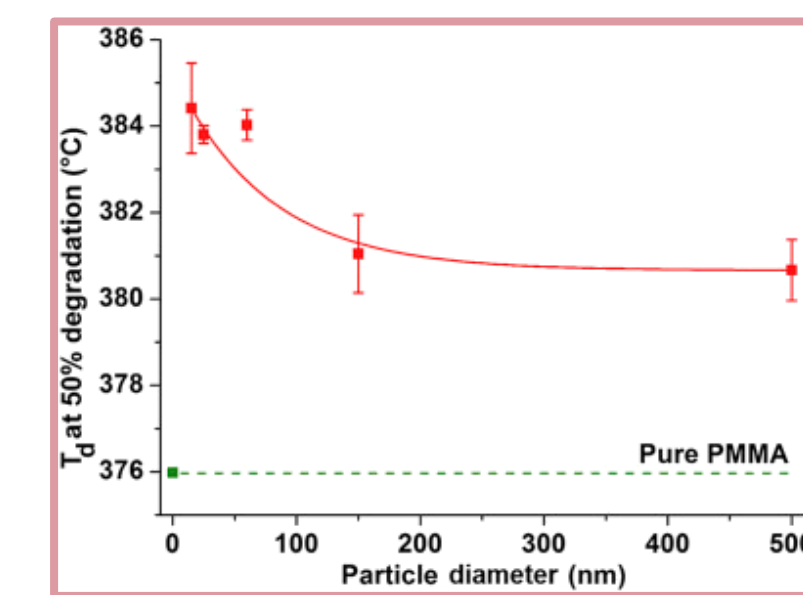


Non-functionalized NPs

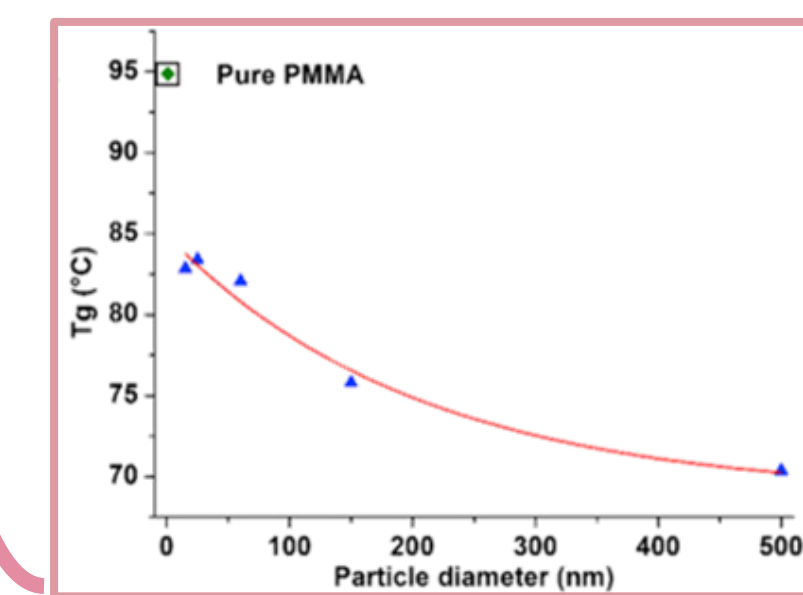
For NPs sizes smaller than 15 nm, only the theoretical study has been performed.



Modulus of elasticity



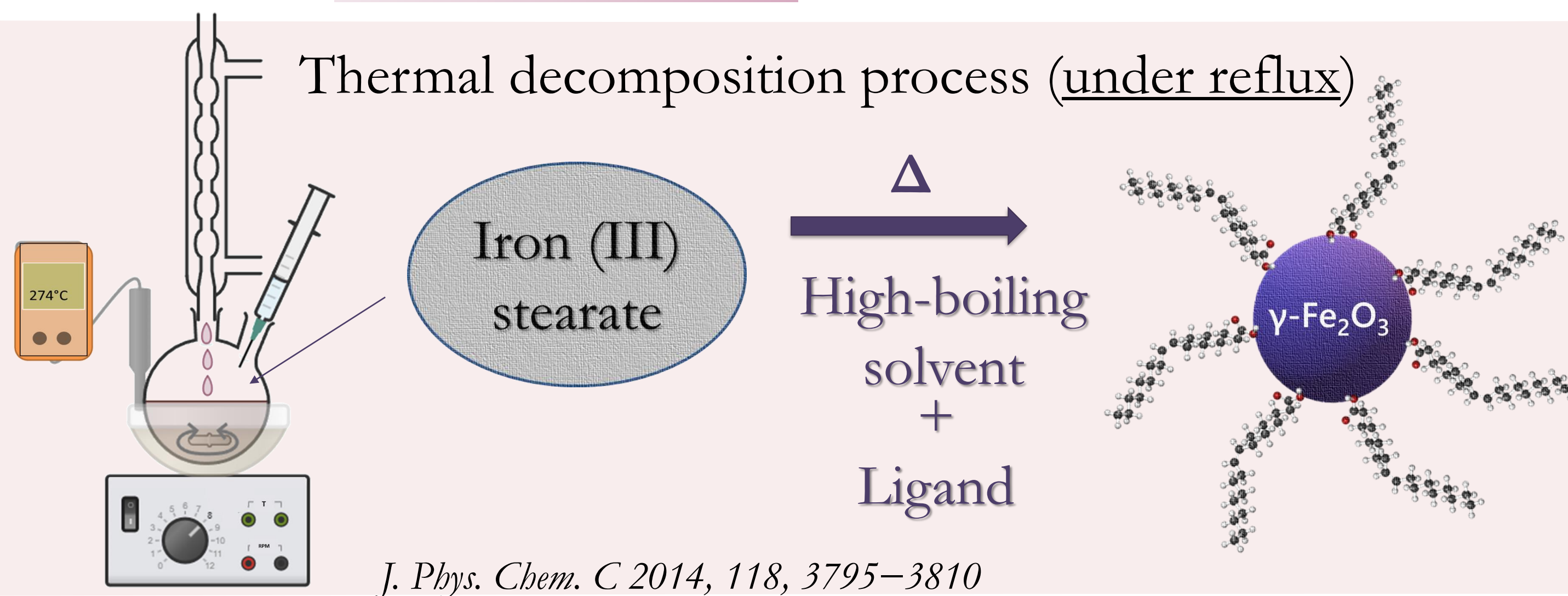
Degradation temperature



Glass-transition temperature

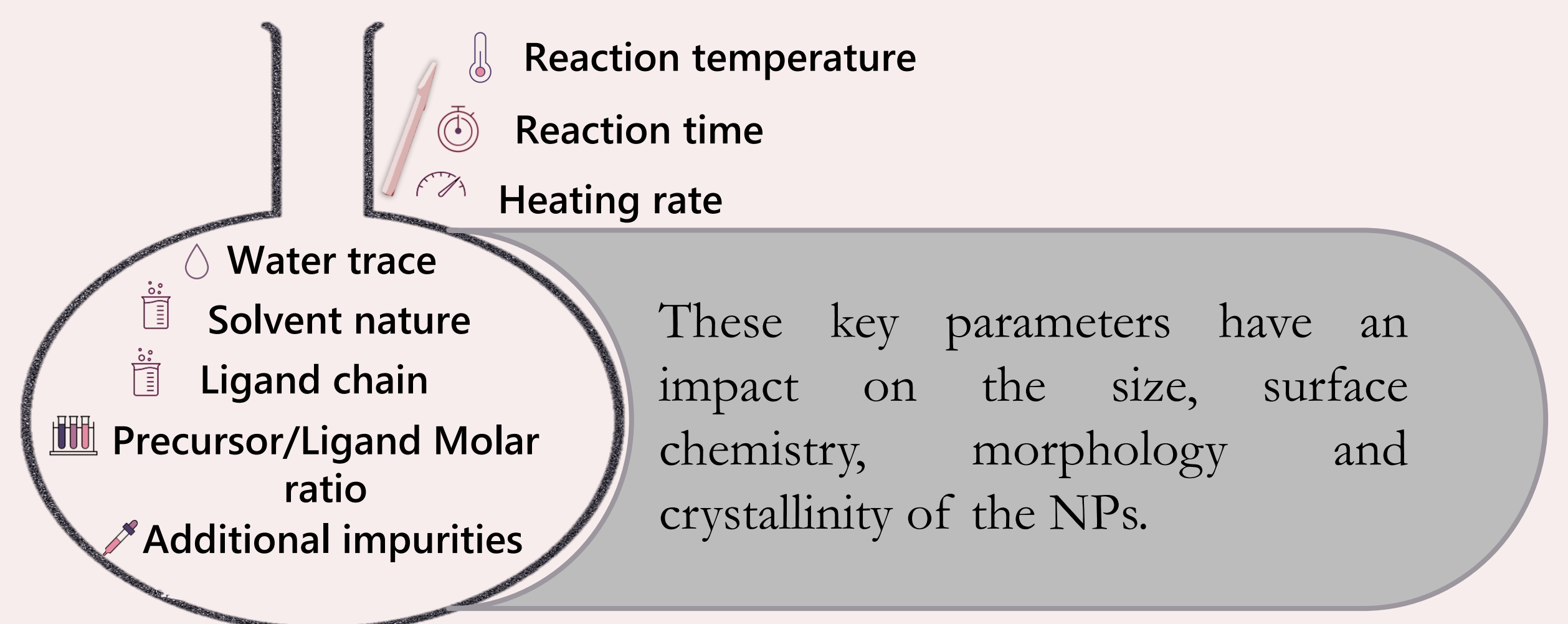
Polymer Testing Volume 56, December 2016, Pages 337-343

Synthesis



J. Phys. Chem. C 2014, 118, 3795–3810

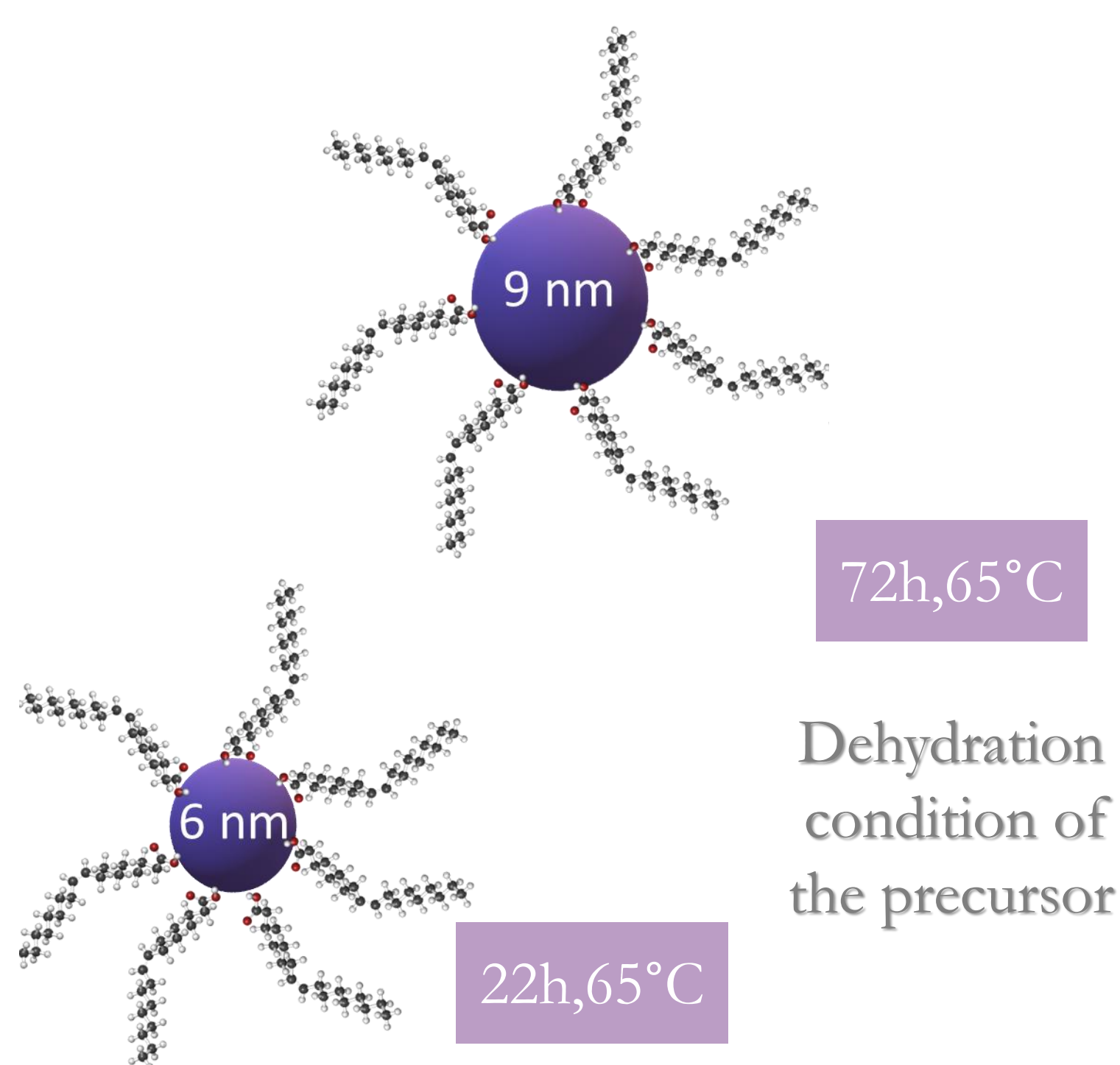
Growth control



These key parameters have an impact on the size, surface chemistry, morphology and crystallinity of the NPs.

Some results

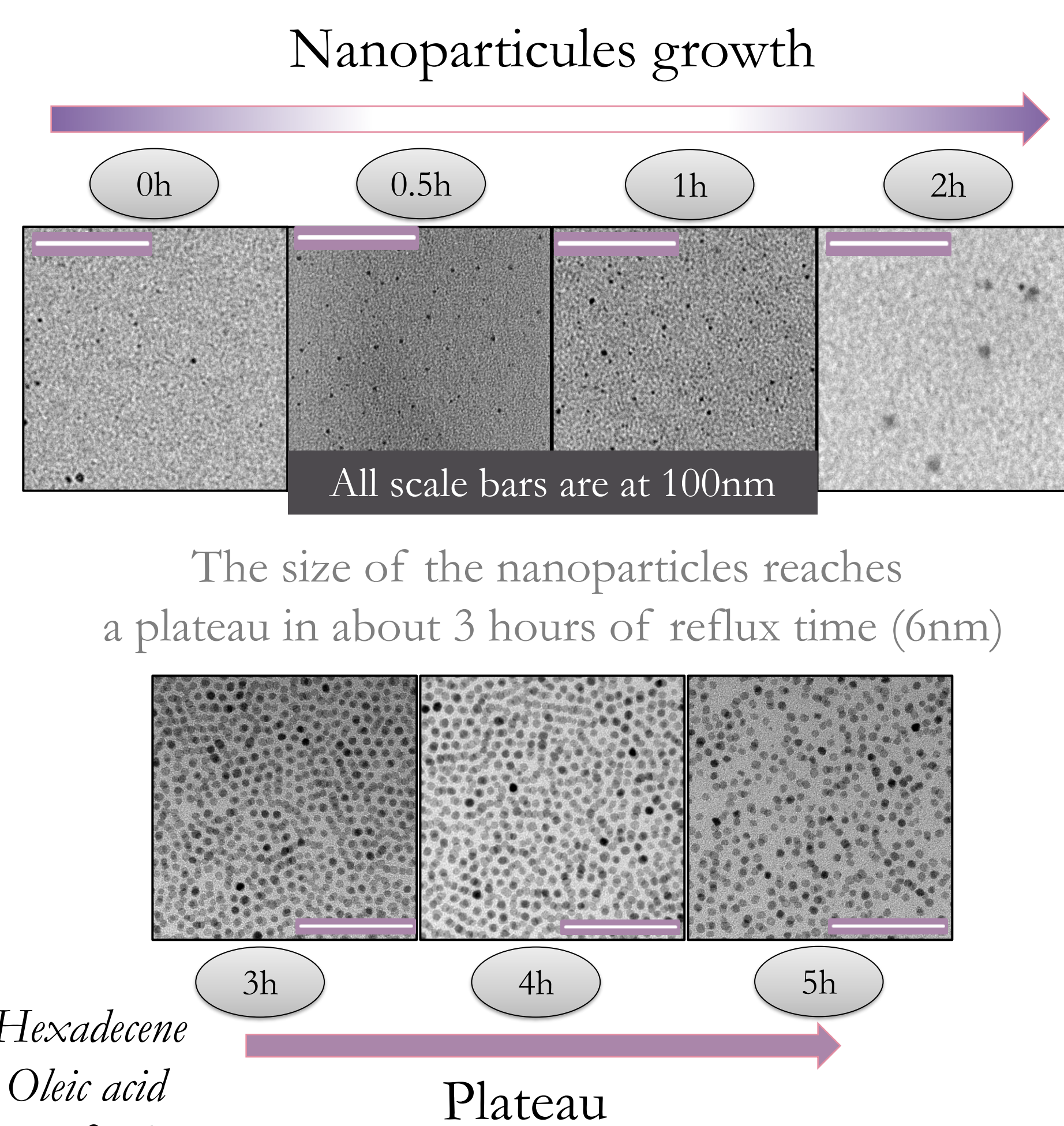
Water trace



Conditions

Solvent : Dioctyl ether
Ligand : Oleic acid
Heating rate 45°C/min

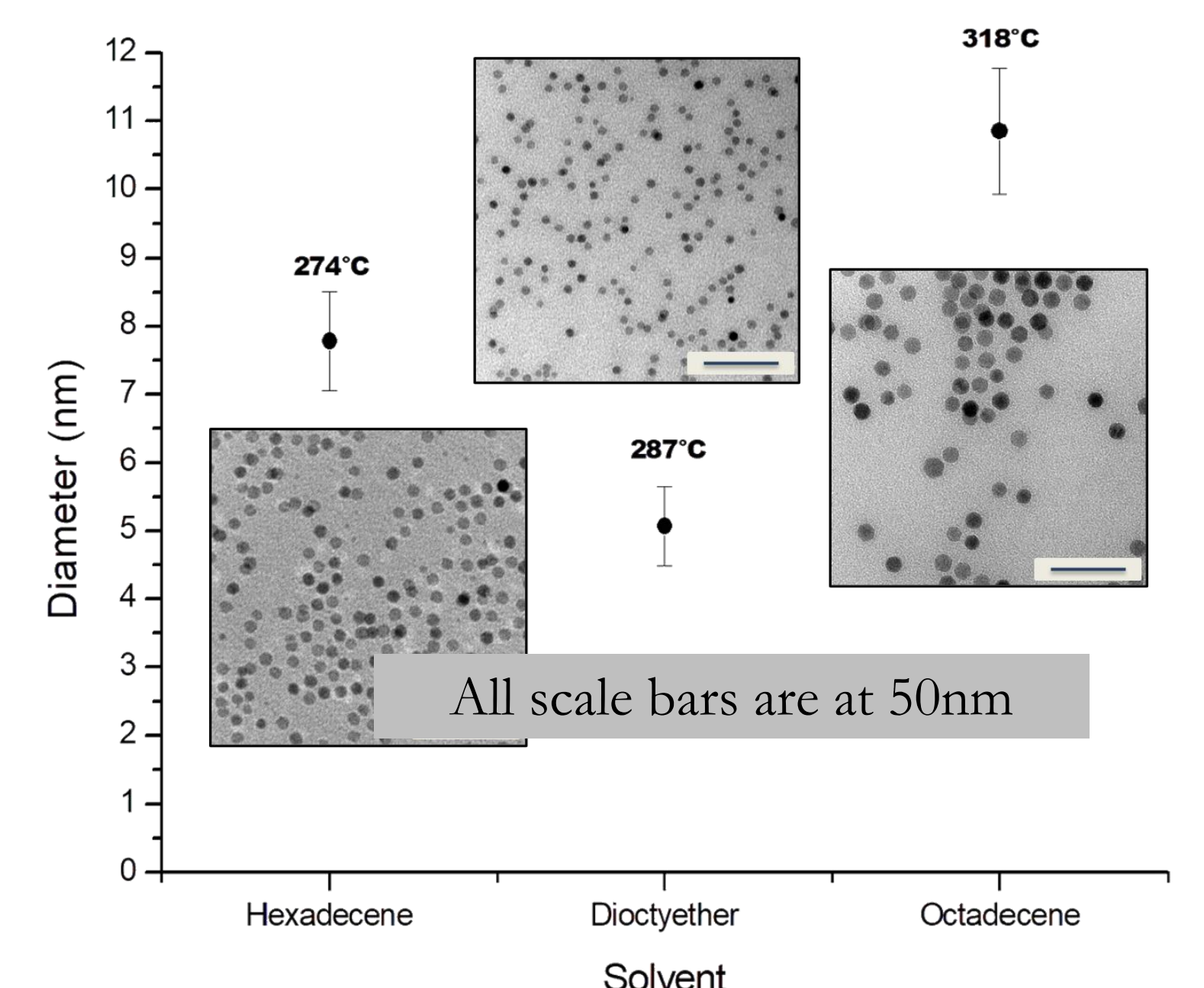
Reflux time



Solvent : Hexadecene
Ligand : Oleic acid
Heating rate 5°C/min

Plateau

Reflux temperature



Reflux temperature (defined by the solvent boiling point) varies the size of the nanoparticles

Ligand : Oleic acid
Heating rate 45°C/min

Conclusion

- ✓ The effects of trace of water, temperature & reflux time, impurities in the precursor on the NPs size and morphology were observed.

Perspectives

- the study will be further pursued for growth control and tuning of structural and chemical properties of nanoparticles in order to elaborate and investigate the mechanical properties of nano-reinforced polymers