THERMAL SUPER-INSULATION AND BIO-BASED MATERIALS

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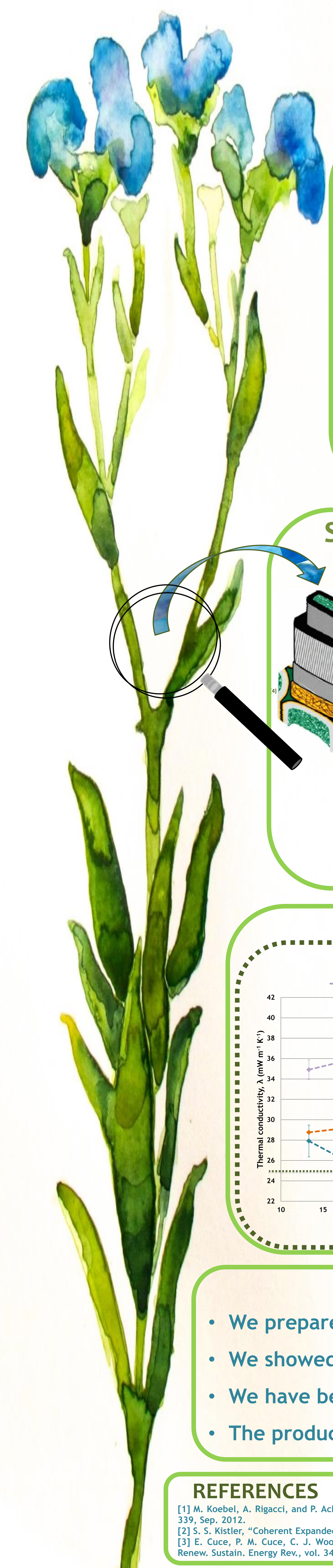
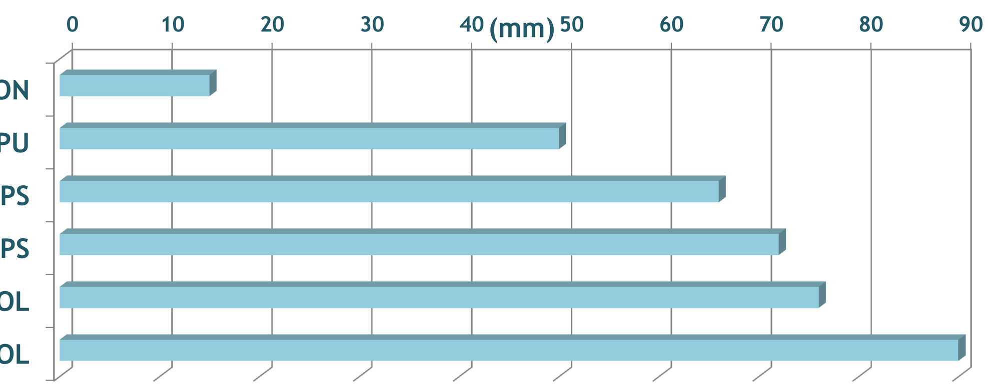


INTRODUCTION

- Thermal conductivity (λ) is a material intrinsic property that estimates its ability to conduct heat. When λ is lower than 0,025 W m^{-1} K^{-1}, materials are called super-insulators [1].
- Aerogels are gels in which the liquid was replaced with a gas. They have a very high porosity, low apparent densities and good thermal properties [2].
- The aim of this work is to prepare super-insulation aerogels from nano cellulose. Structural, mechanical, and thermal conductivity properties were studied.

INSULATION THICKNESS FOR A THERMAL RESISTANCE OF 2 m^2KW^{-1}

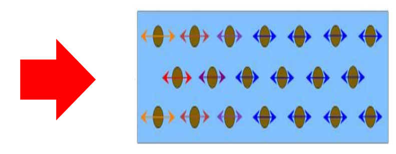


STRUCTURE OF MATERIAL

THERMAL TRANSFER IN INSULATION MATERIALS

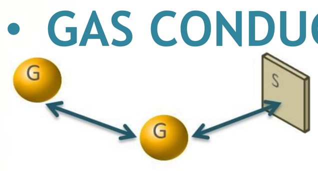
$$\lambda_{tot} = \lambda_{gas} + \lambda_{solid} + \lambda_{rad} (Wm^{-1}K^{-1})$$ [3]

- SOLID CONDUCTION (PHONONS)

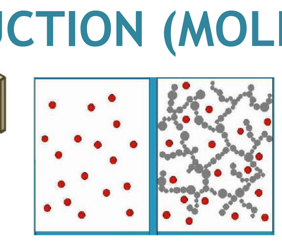


DENSITY → ULTRA POROUS MATERIAL

- GAS CONDUCTION (MOLECULES)



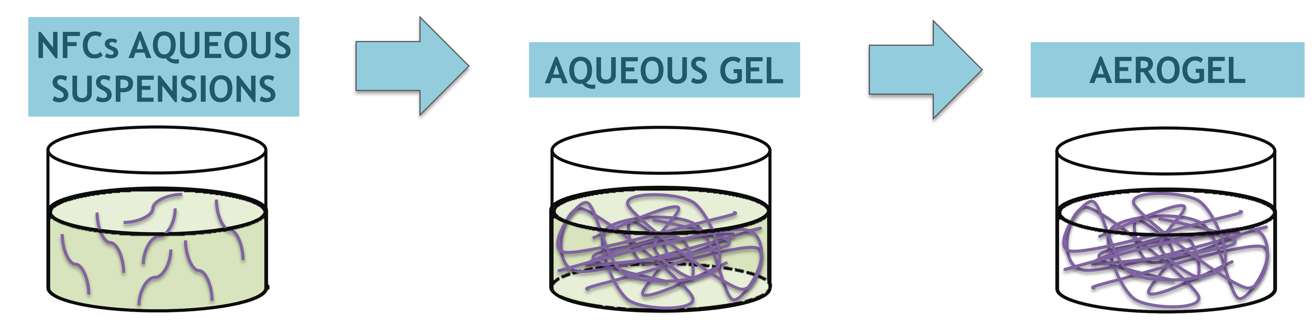
EFFECT KNUDSEN



CONFINEMENT → MESOSTRUCTURED MATERIAL

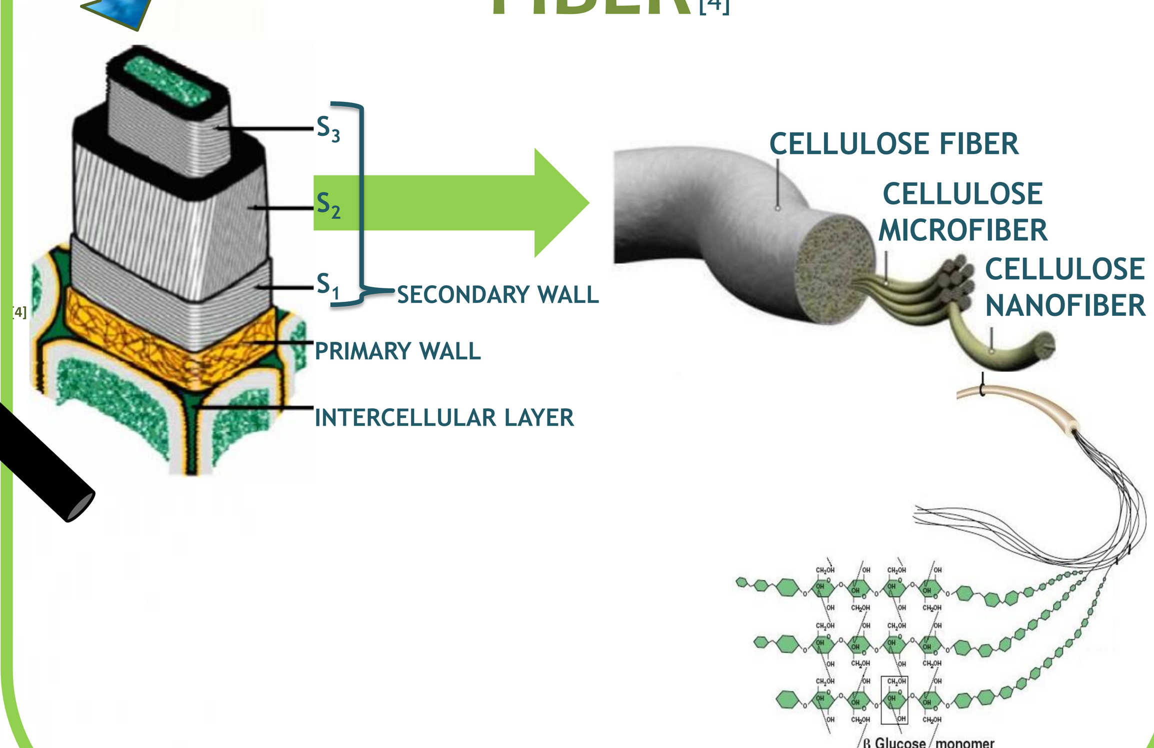
- THERMAL RADIATION (PHOTONS) → OPAQUE STRUCTURE

NANO CELLULOSE AEROGEL

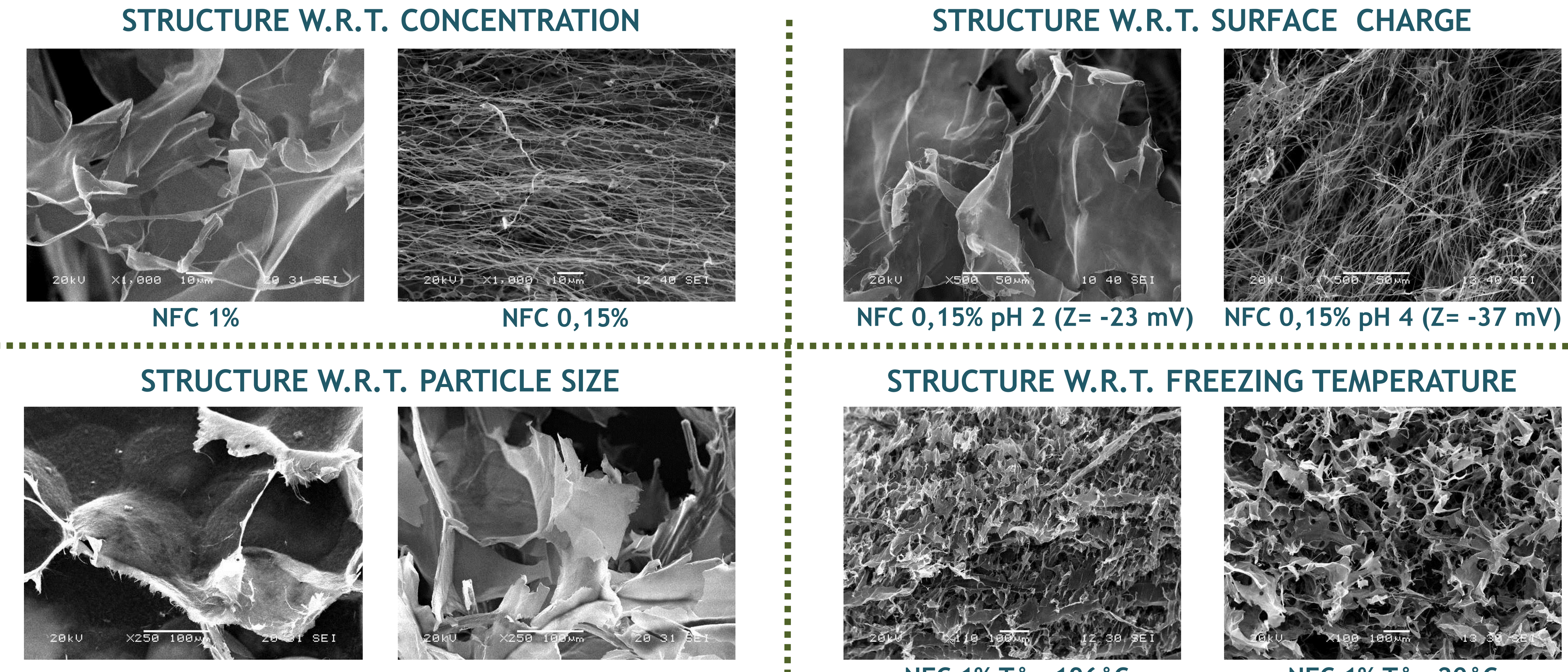


FREEZE DRYING

STRUCTURE OF VEGETAL FIBER [4]



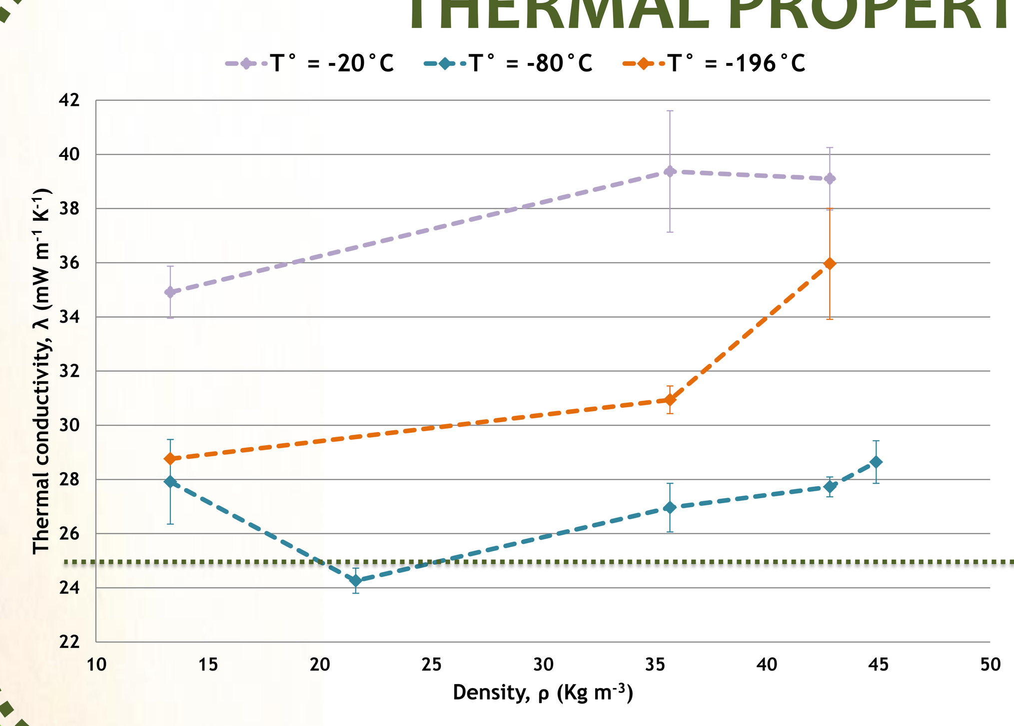
FREEZE DRYING OF NFC GELS



PREPARATION PARAMETERS CAN TUNE THE MATERIAL STRUCTURE

RESULTS

THERMAL PROPERTIES

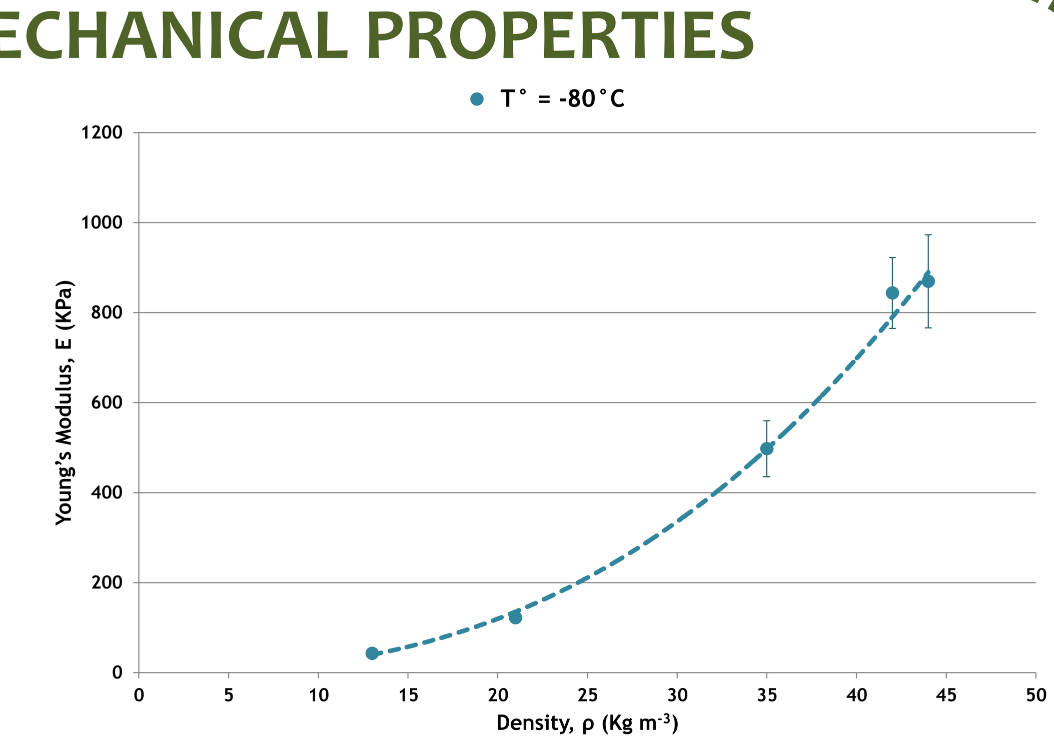


ρ (Kg m^{-3})	λ (mW$m^{-1}K^{-1}$)
13	29,91 ± 1,56
21	24,26 ± 0,46
35	26,96 ± 0,89
42	27,72 ± 0,36
44	28,64 ± 0,78

SUPER ISOLATION
$\lambda < 25\ mW\ m^{-1}K^{-1}$

MECHANICAL PROPERTIES

ρ (Kg m^{-3})	E (KPa)
13	42,5 ± 6,8
21	122,1 ± 11,5
35	497,6 ± 62,2
42	843,7 ± 78,7
44	869,5 ± 103,3



CONCLUSION

- We prepared nano cellulose aerogel materials with a novel method (Freeze-drying vs Super Critical drying) [5], [6], [7], [8].
- We showed that the freeze-drying parameters are controlling the aerogels structure (Films vs fibers) and their pore size.
- We have been able to obtain competitive thermal conductivity values (0,024 W m^{-1} K^{-1}) [5], [6], [7].
- The produced aerogel material have promising mechanical properties [5], [6], [7].

REFERENCES

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