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Biochar based silicon composites for sensors applications

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BIOCHAR BASED SILICON COMPOSITES FOR SENSORS APPLICATIONS

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- Biochar in **Composites**
- Biochar **Electrical conductivity**
- Biochar in **Silicon** matrix
- Biochar as possible **carbon filler** in composite
- Conclusions

Biochar in Composite



Goal: use biochar to increase:

- Mechanical properties
- Electrical properties
- (Thermal properties)



In composites based on:

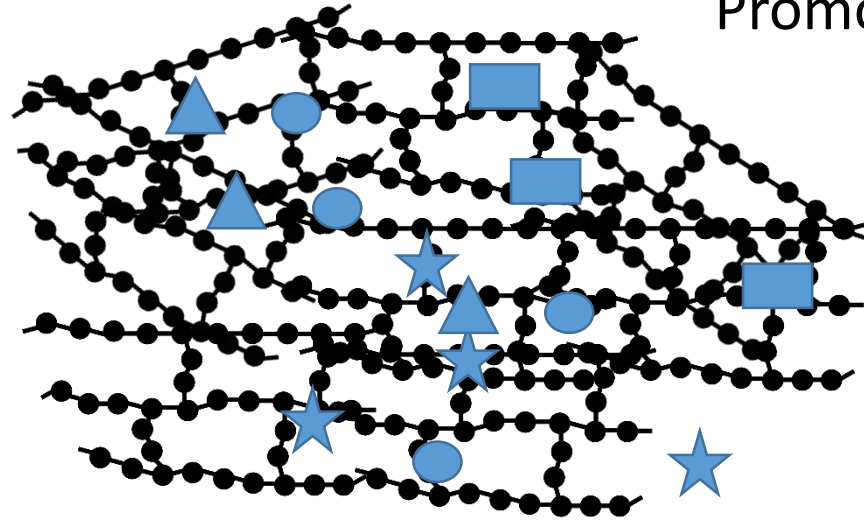
- **Polymers**
- Cement
- ...

Why biochar?

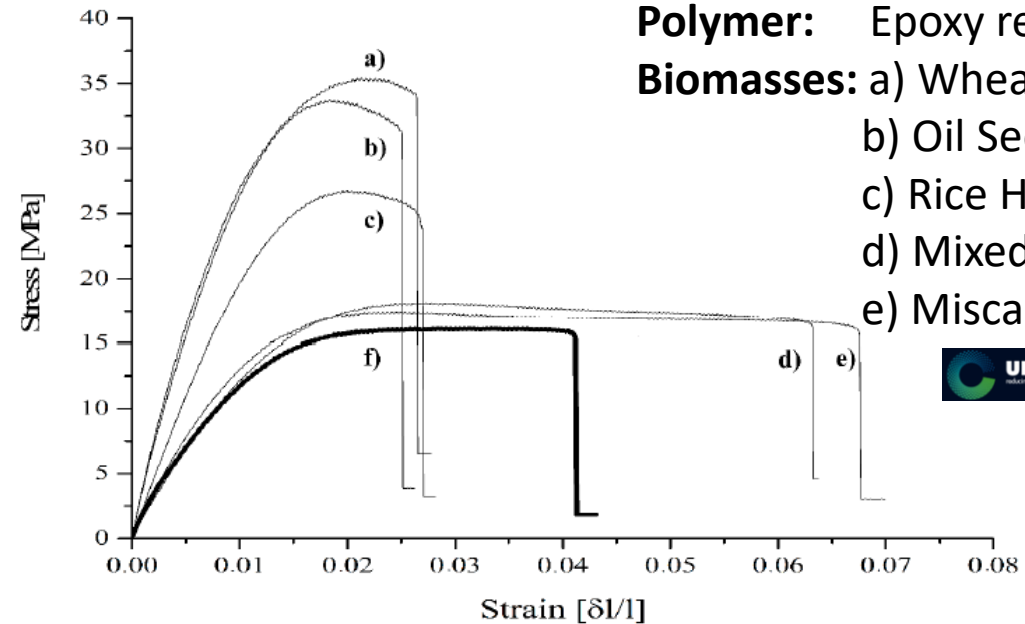
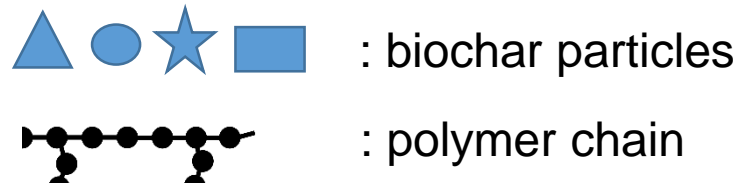


- High carbon content
- Porous
- Stable (low reactivity)
- Low cost/recycling material
- Quite easy to disperse

Biochar in Composite



Promotion of : → mechanical adhesion of polymer chains
 → electrical transport of electrons

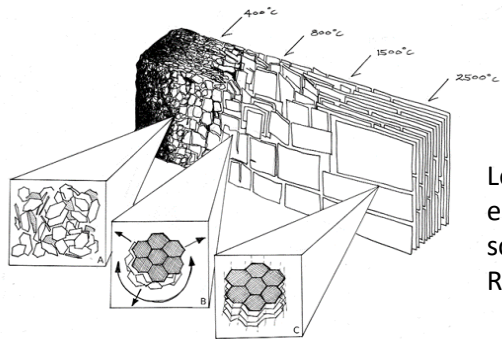
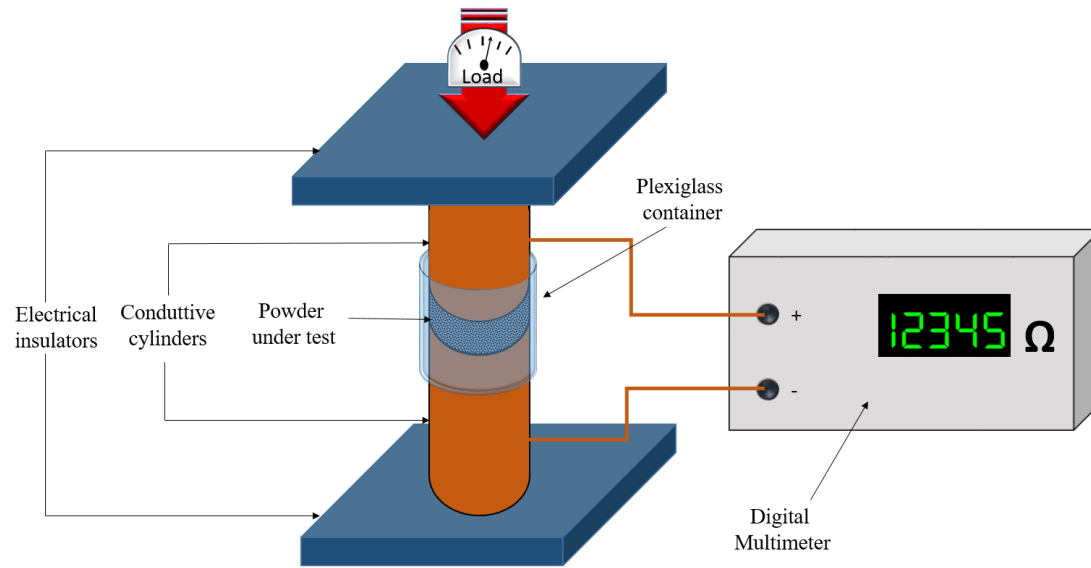


Polymer: Epoxy resin
Biomasses: a) Wheat straw WSP
 b) Oil Seed Rape OSR
 c) Rice Husk RH
 d) Mixed softwoods SWP
 e) Miscanthus Straw MSP

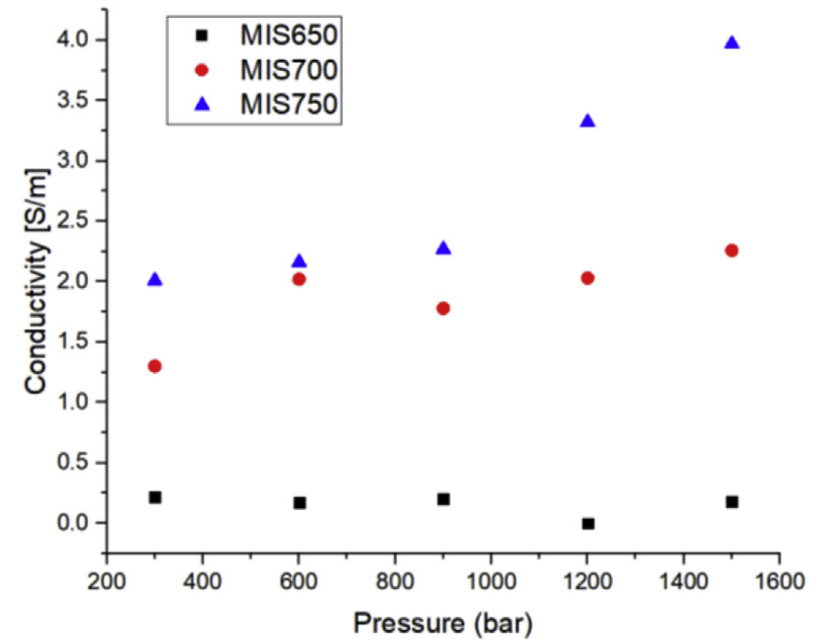


Biochar Electrical Conductivity

Evaluation of biochar electrical conductivity **before** composite preparation



Lehman J et al, Biochar for environment management: science and technology, Routledge, 2012



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Research paper

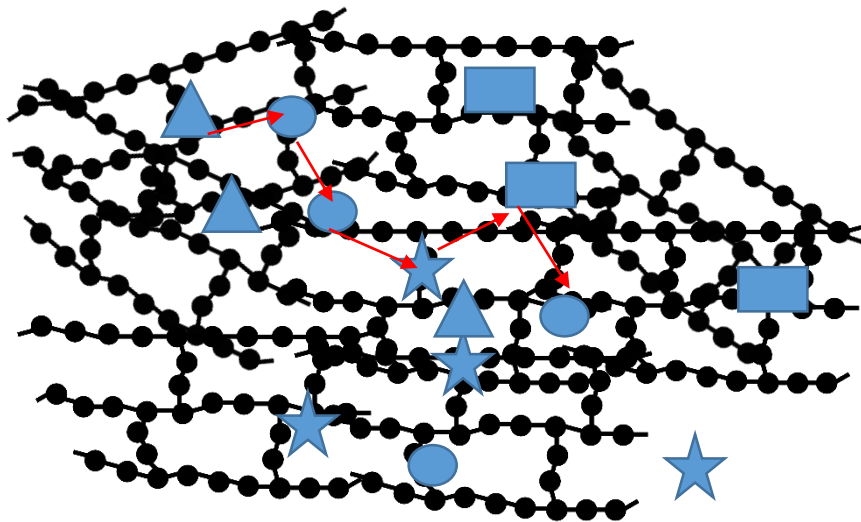
Analysis of biochar with different pyrolysis temperatures used as filler in epoxy resin composites

Mauro Giorcelli^a, Patrizia Savi^{b,c}, Aamer Khan^{a,c}, Alberto Tagliaferro^{b,d}



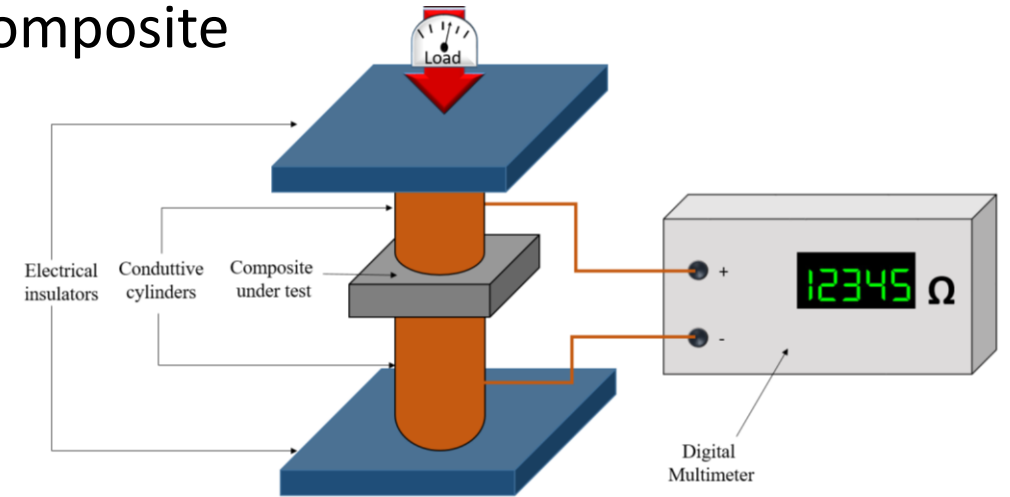
Biochar Electrical Conductivity

Evaluation of biochar electrical conductivity in composite

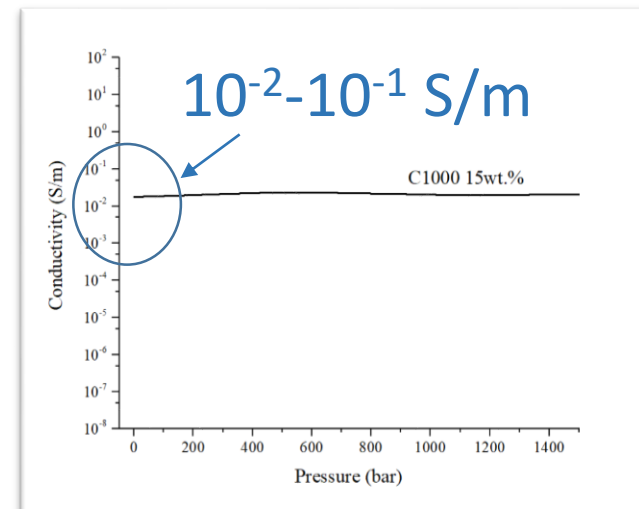


: biochar particles

 : polymer chain



Ohm law for conductivity (σ): $\sigma = \left(\frac{l}{RS} \right)$



Polymer: Epoxy resin
Biomasses: Coffee

Presented at:





Biochar in Silicon Matrix

Evaluation of biochar electrical conductivity in composite

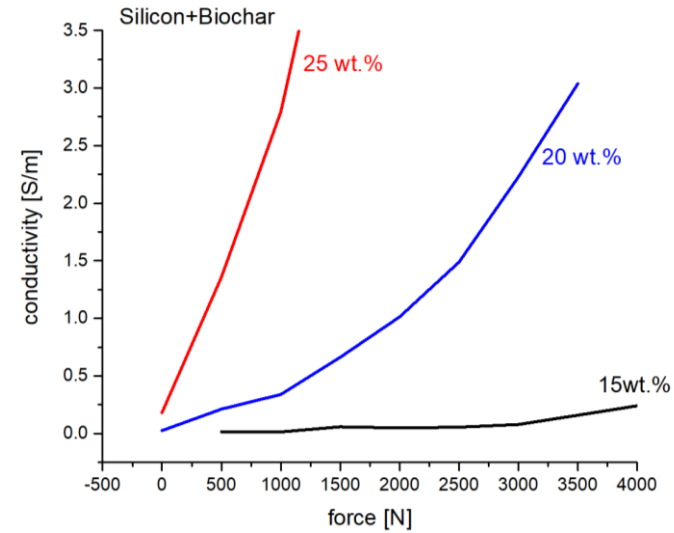
What we have to take in account to increase the electrical conductivity in composites:

- **Particle size** (low dimensions → best dispersions → increase the electrical conductivity)
- **Biochar graphitization grade** (it increases with temperature treatments ($>400^{\circ}\text{C}$) → Raman)
- **Biochar porosity** in function of its ability to be grinded in small particles (CO₂ activation could help, preliminary tests)
- **Low ash content**

Biochar in Silicon Matrix

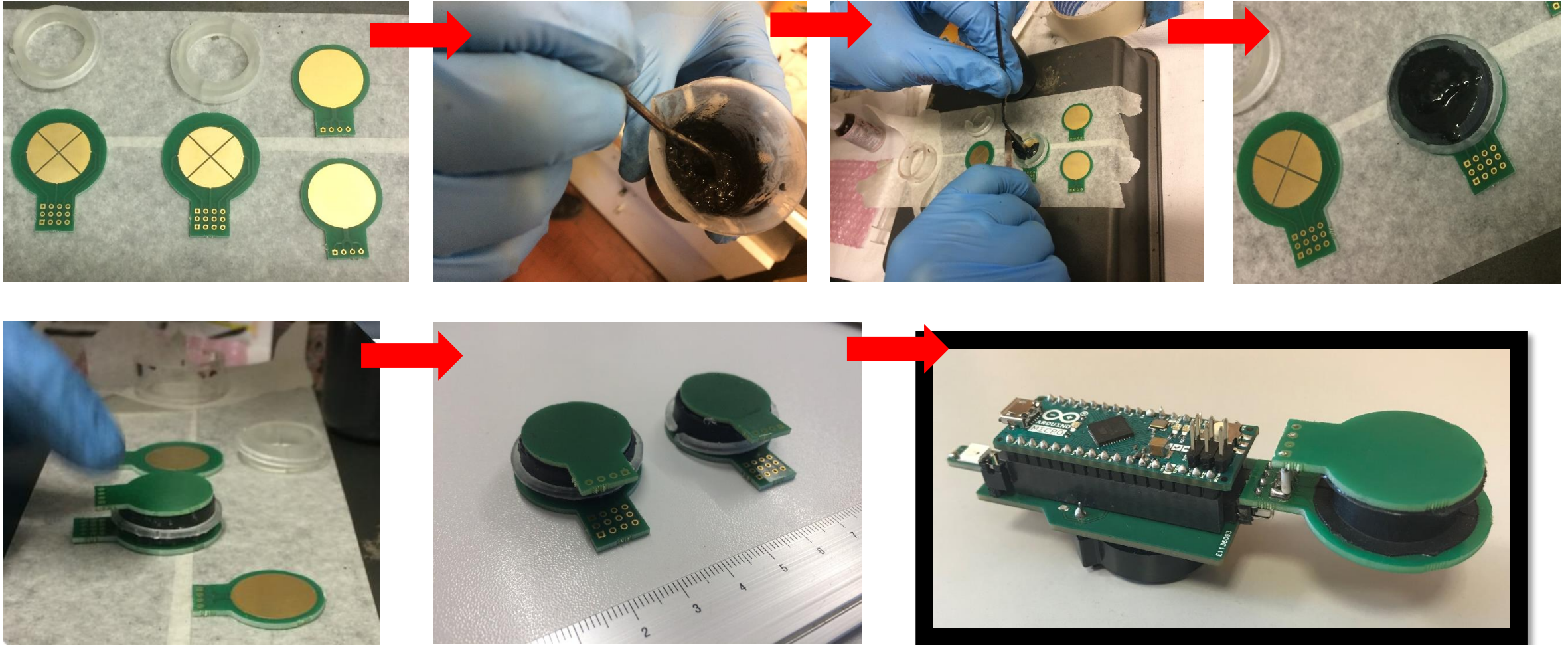
Goal: sensor application

Suggested polymer: soft polymer → **Silicon**



Behaviour like solid in a liquid, to study well...

Biochar in Silicon Matrix

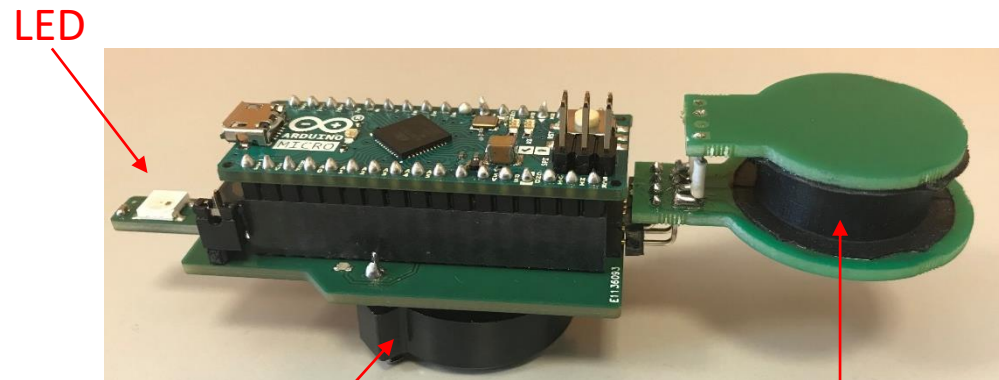


Biochar in Silicon Matrix

Realization of pressure sensor device based on biochar

Polymer: Silicon

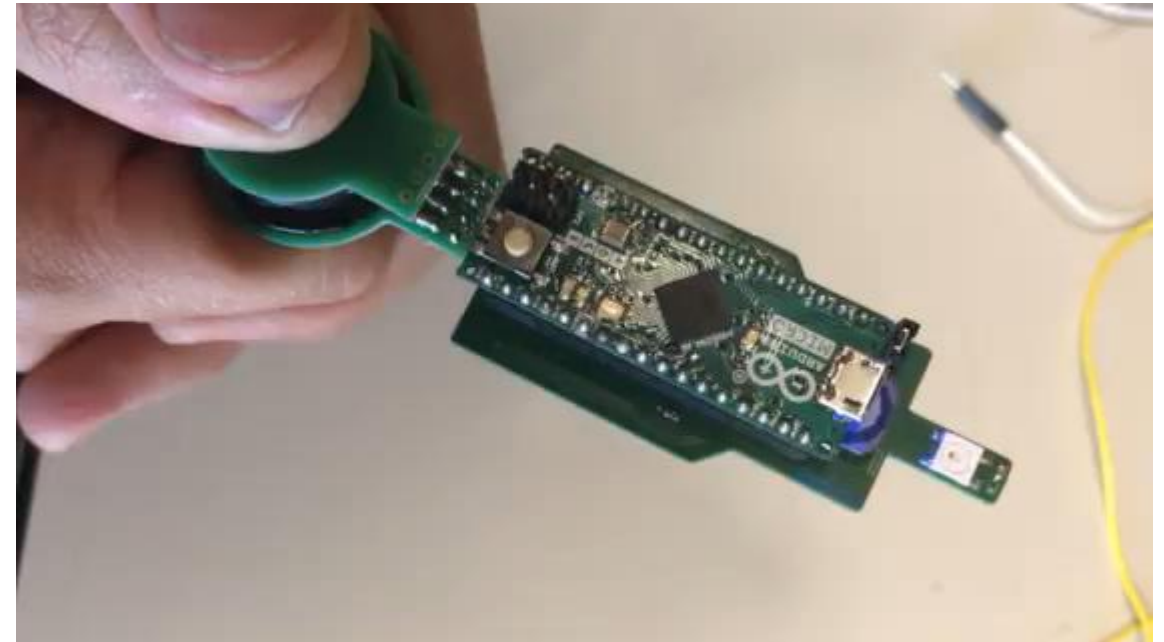
Biochar: Olive 1500



LED

BATTERY

SILICON-BIOCHAR
PRESSURE
SENSOR



- Biochar represents a great opportunity in composite field
- Indisputable advantages: → low cost
→ green/ recycling material

... And it works!

Thanks to:



Mattia Bartoli, Post. Doc



Massimo Rovere, Raman specialist



Pravin Jagadale, Researcher



Prof. Carlo Rosso, Mechanical



Alessandro Sanginario, Researcher



Prof. Alberto Tagliaferro, Head

