Development of new functional inks for bio-monitoring applications

Nikola Perinka, Cristian Mendes Felipe, Carmen Rial Tubio, Senentxu Lanceros-Méndez

BCMaterials, Basque Center on Materials, Applications and Nanostructures

H2020-ICT-02-2018

Contents

Active and Smart Mate

- Magnetic Shape Mer Alloys
- Magnetocaloric
- Elastocaloric
- Piezoelectric
- Piezoresistive
- Self-healing

Nanostructured Materials

- Magnetic nanoparticles produced by bacteria
- Nanoparticles and nanostructures (magnetic, metallic, dielectric…)
- Porous materials (MOFs, Zeolites…)

Micro & Nano-devices

- Radiofrequency instrumentation
- Force, deformation, magnetic, magnetostrictive and chemical sensors

Functional Surfaces and Coatings

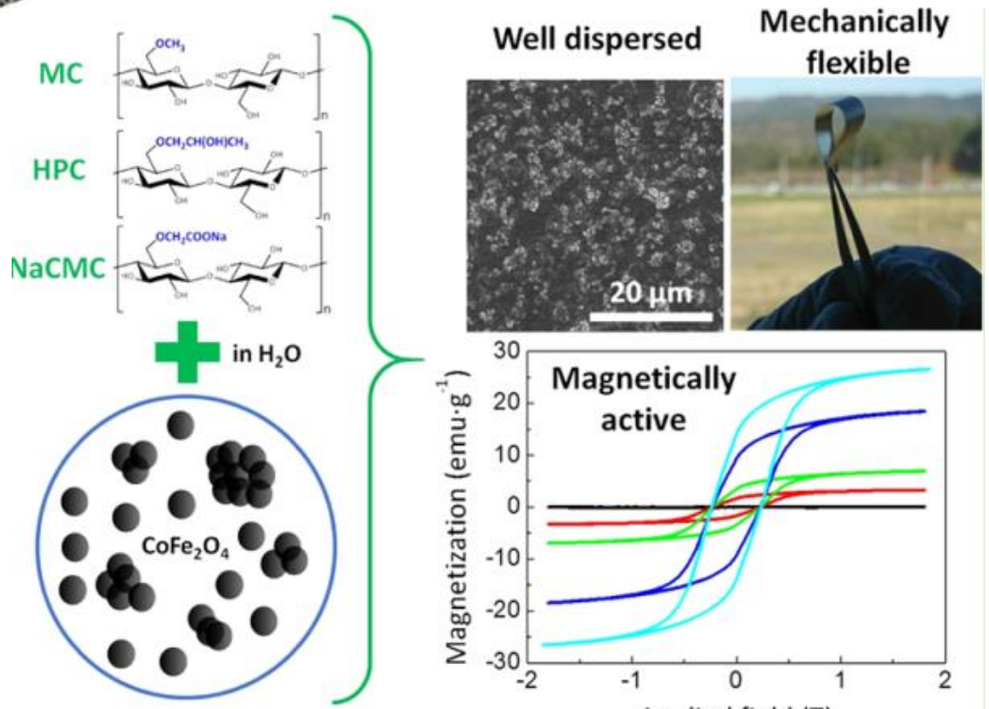
- Patterned surfaces and films
- Ink-printed functional materials

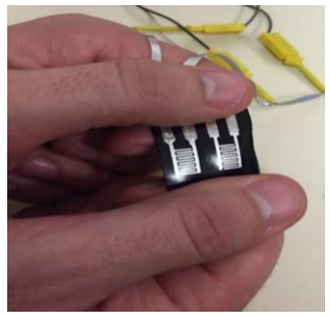
Advanced Functional Materials

- Fuel cells and batteries, Sensors & biosensors, Photovoltaic materials materials and processing for permanent magnets

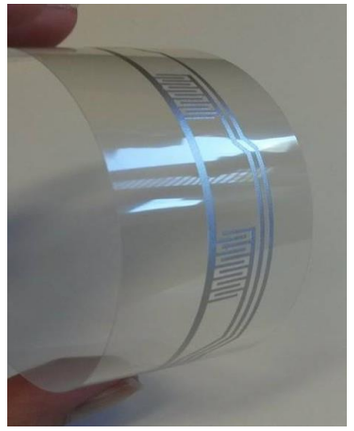
New

Biopolymer based inks





Stretchable

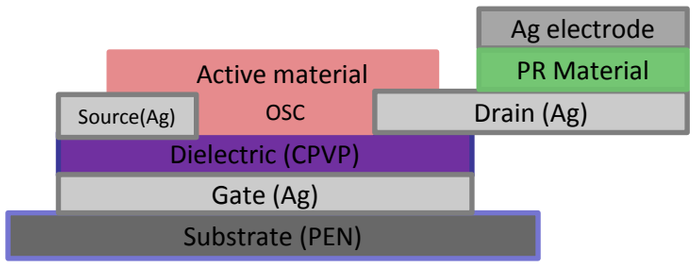


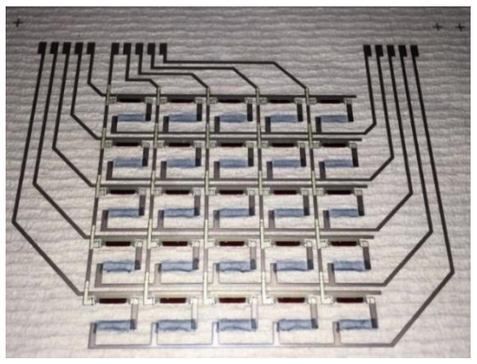
Flexible

Stress and Strain sensors

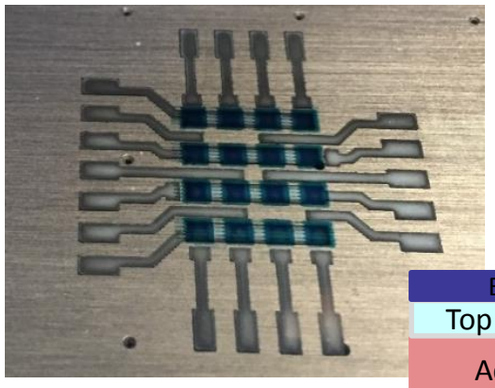
On different substrates

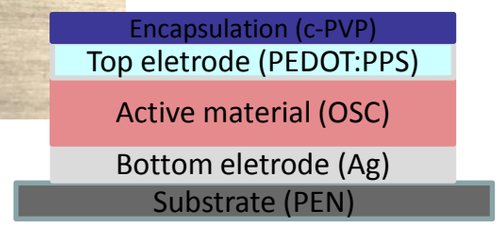
Organic TFT based piezoresistive array



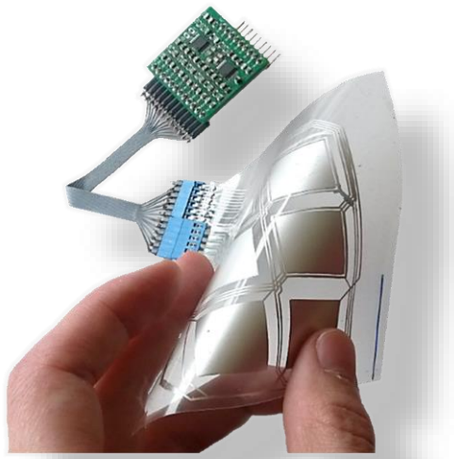


Printed photodetectors

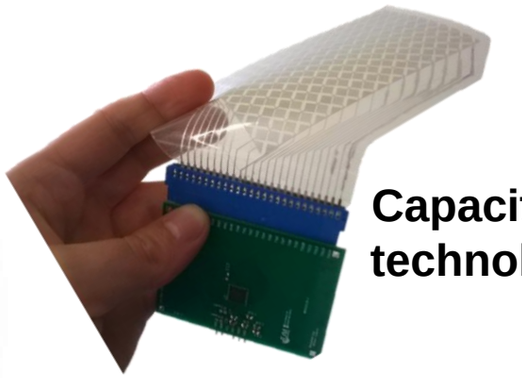




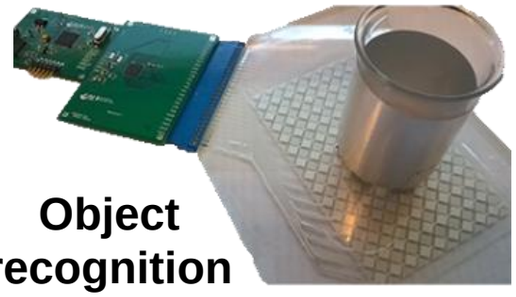
Interactive touch surfaces



Piezoelectric technology

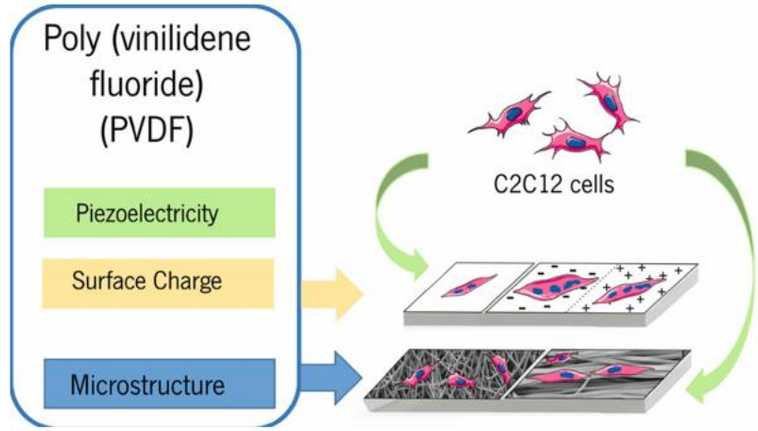


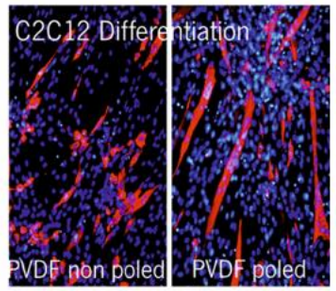
Capacitive technology



Object recognition

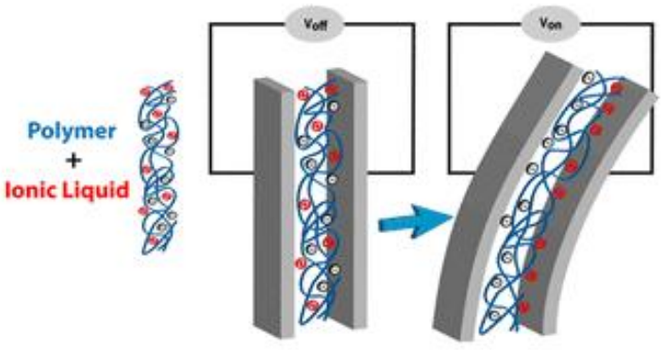
Electroactive biomaterials

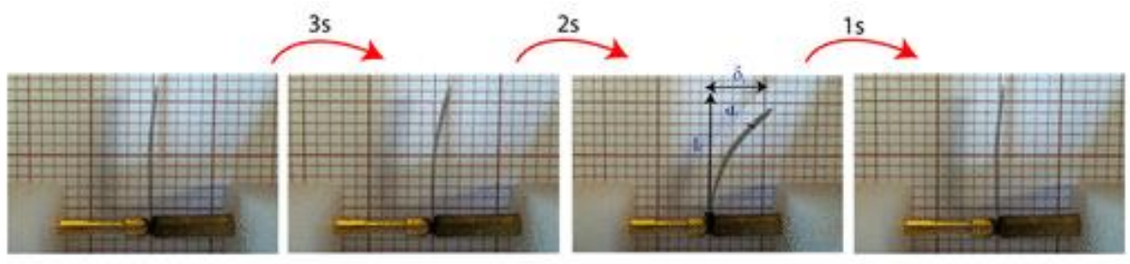




Muscle cells differentiation

Soft Actuators





1. Introduction

Wearable multiplexed biomedical electrodes

Offers interesting opportunities for advanced health solutions for bio-monitoring

Biomonitoring device will be designed and integrating on different flexible and thin layer systems

Functional inks

- Conductive and semiconductive ink formulation

- Based on electroactive polymers
- Functional fillers
- Ensure biocompability components
- Water-based formulation
- Stretchable

Strategy fabrication bio-monitoring devices

Bioink synthesis

- Components
- Stability
- Dispersion
- Rheology

2D Printing

- Design
- Substrate
- Screen-printing
- Ink-jet printing

Post-processing

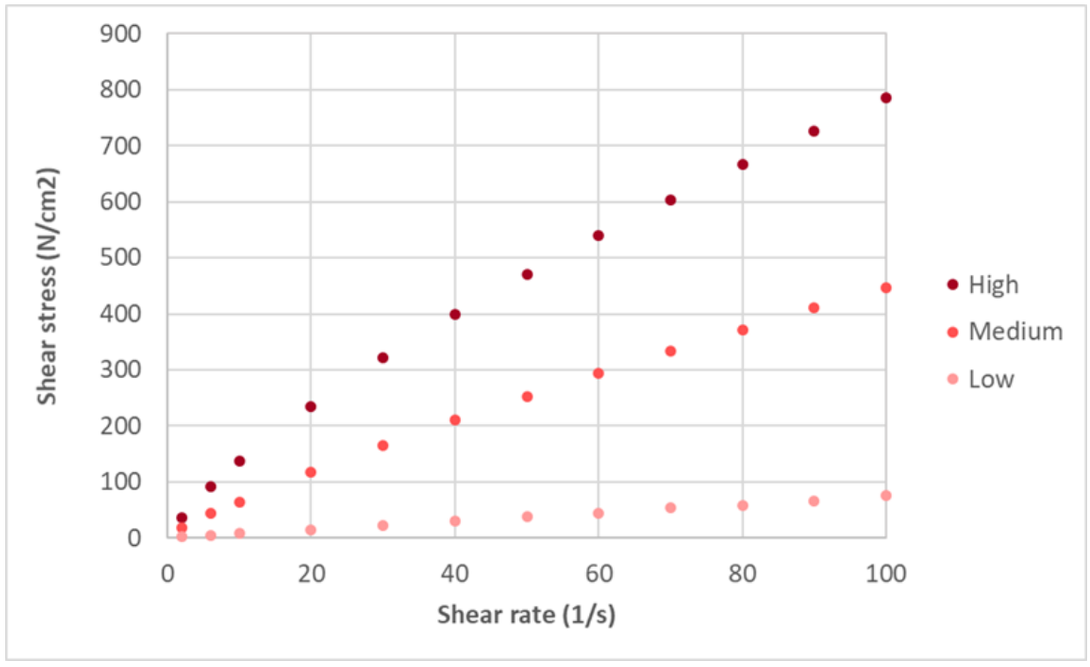
- Drying
- Integration
- Mechanical and chemical resistance

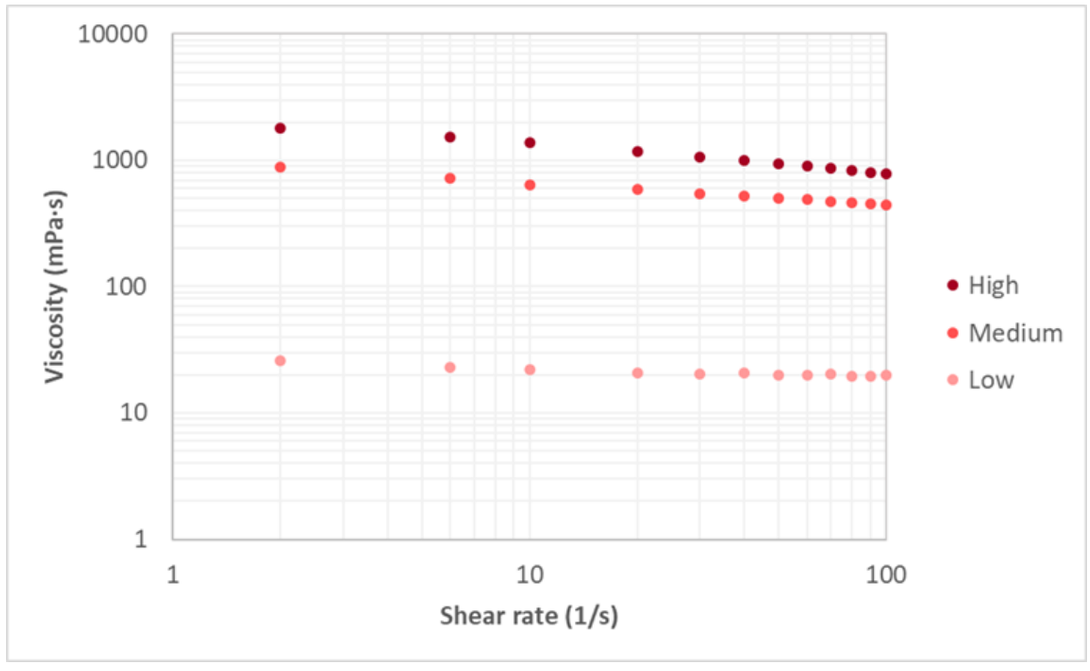
2. Results

Synthesis and characterization rGO based inks

Components ink

Active: **Reduced graphene oxide (rGO)**
Binder: Based on cellulose derivates (or other water-soluble polymers)
Solvent: EtOH+Desionized H2O





Ink rheology tailored for printing techniques

Synthesis and characterization rGO based inks

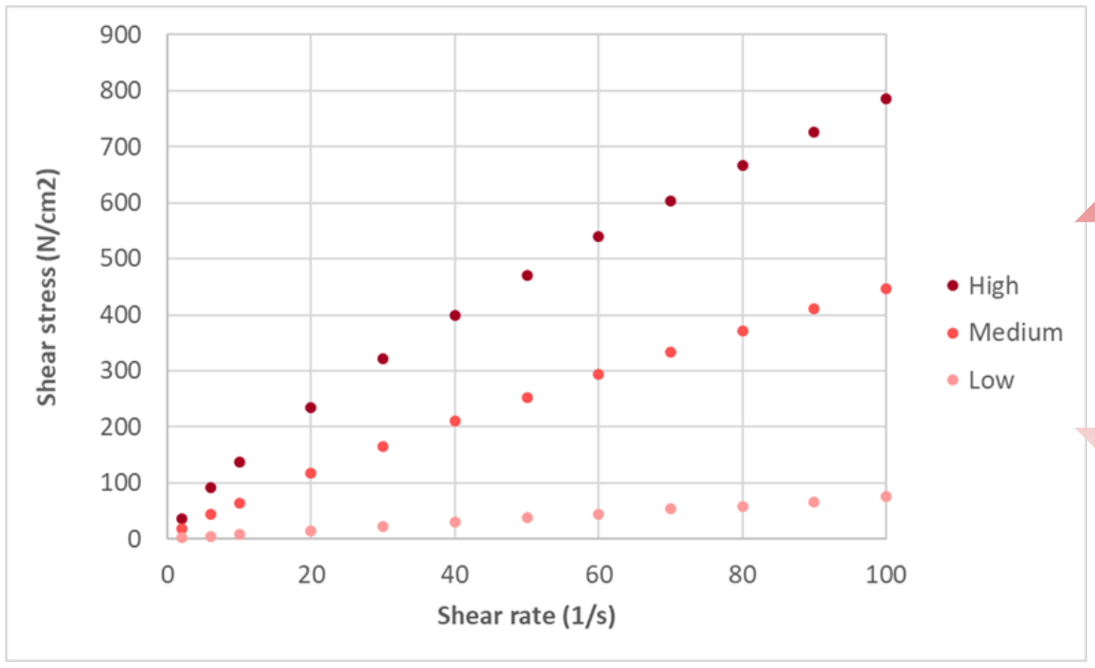
Components ink

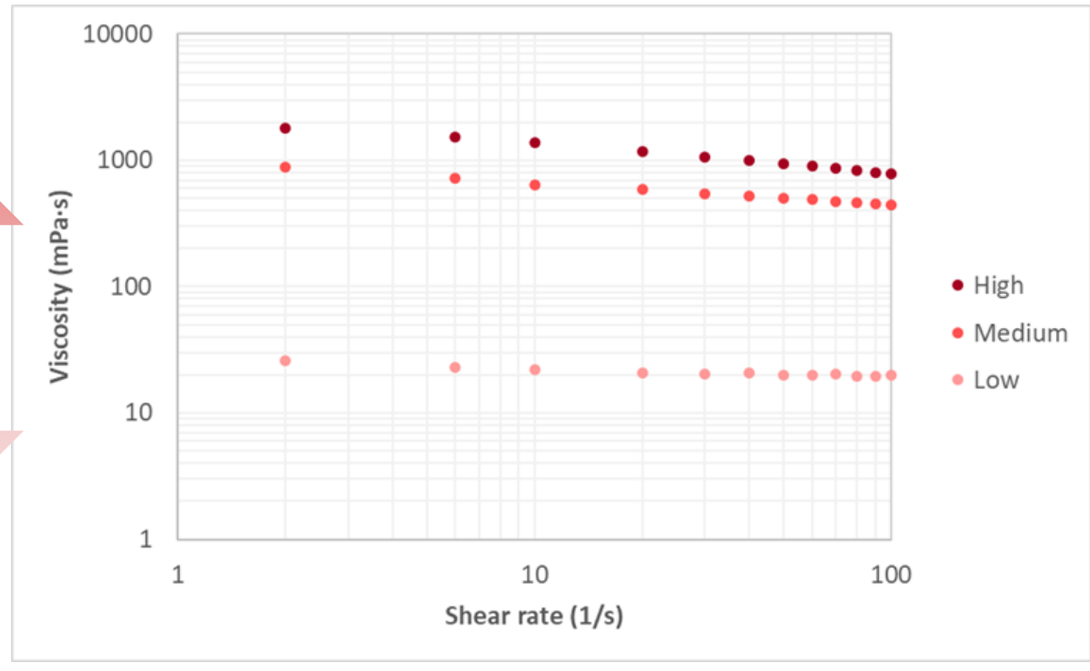
Active: **Reduced graphene oxide (rGO)**

Binder: Based on cellulose derivates (or other water-soluble polymers)

Solvent: EtOH+Desionized H2O

Screen printing





Inkjet printing

Ink rheology tailored for printing techniques

Synthesis and characterization rGO based inks

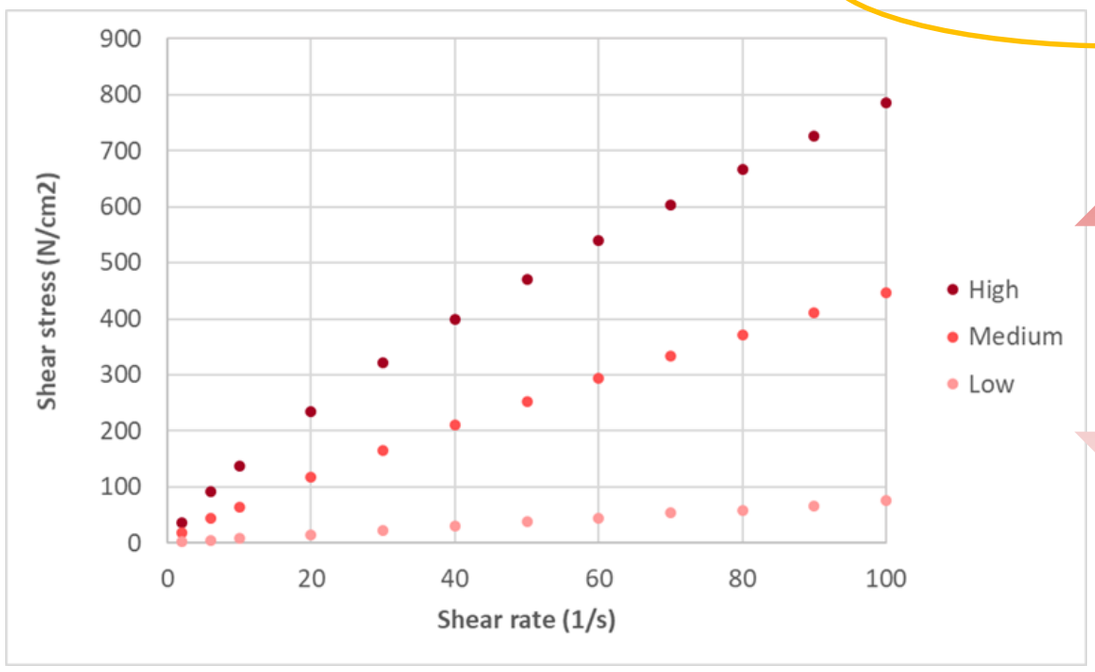
Components ink

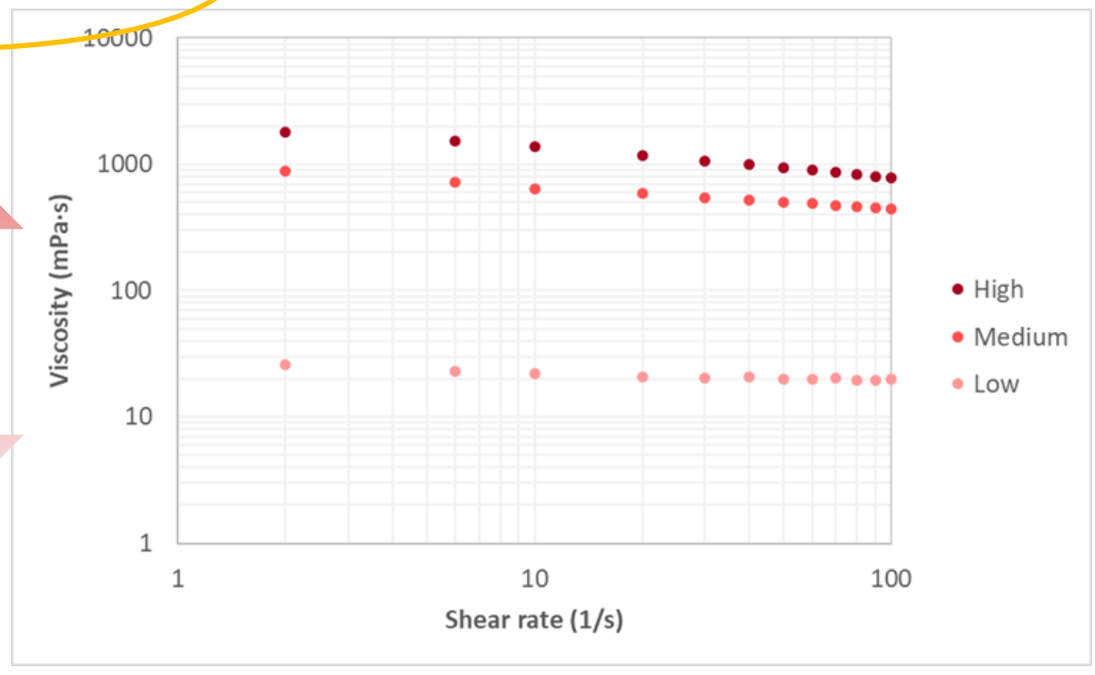
Active: **Reduced graphene oxide (rGO)**

Binder: Based on cellulose derivates (or other water-soluble polymers)

Solvent: EtOH+Desionized H2O

Screen printing





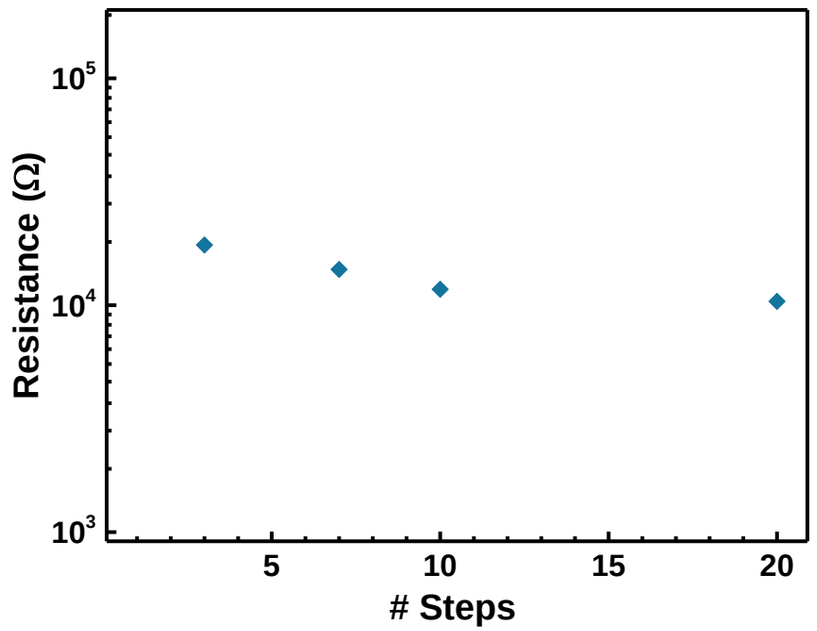
Inkjet printing

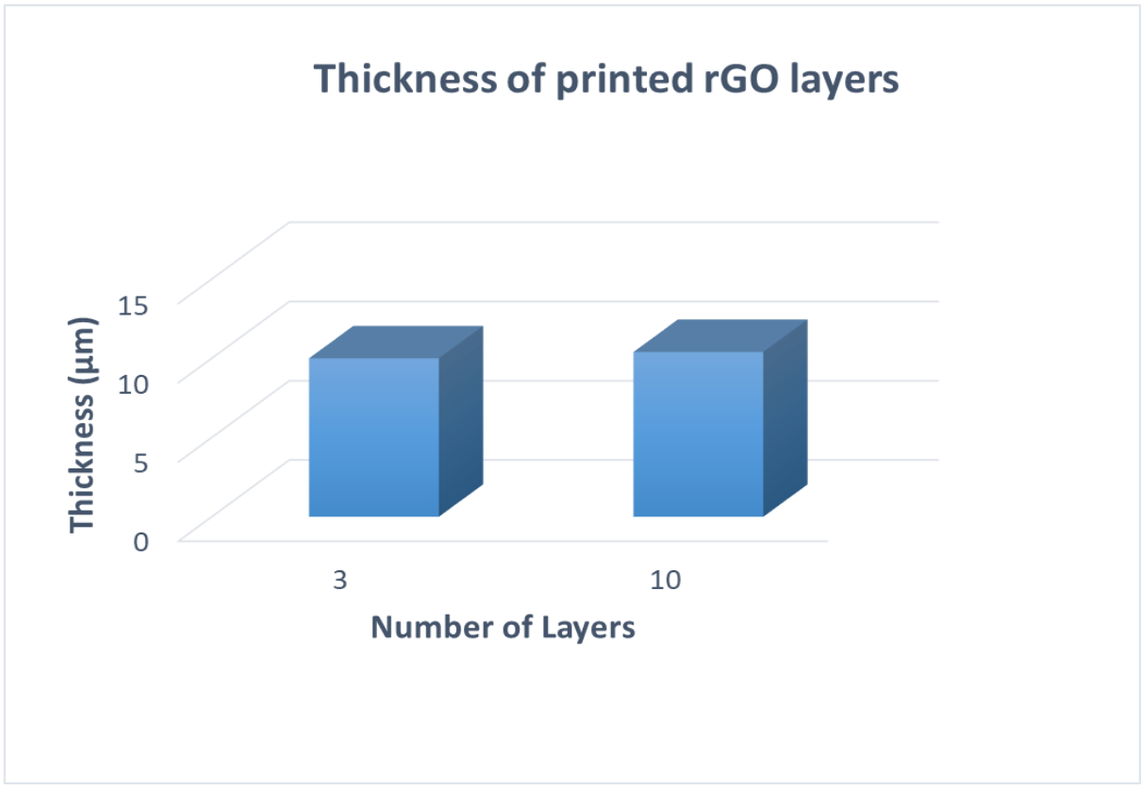
Ink rheology tailored for printing techniques

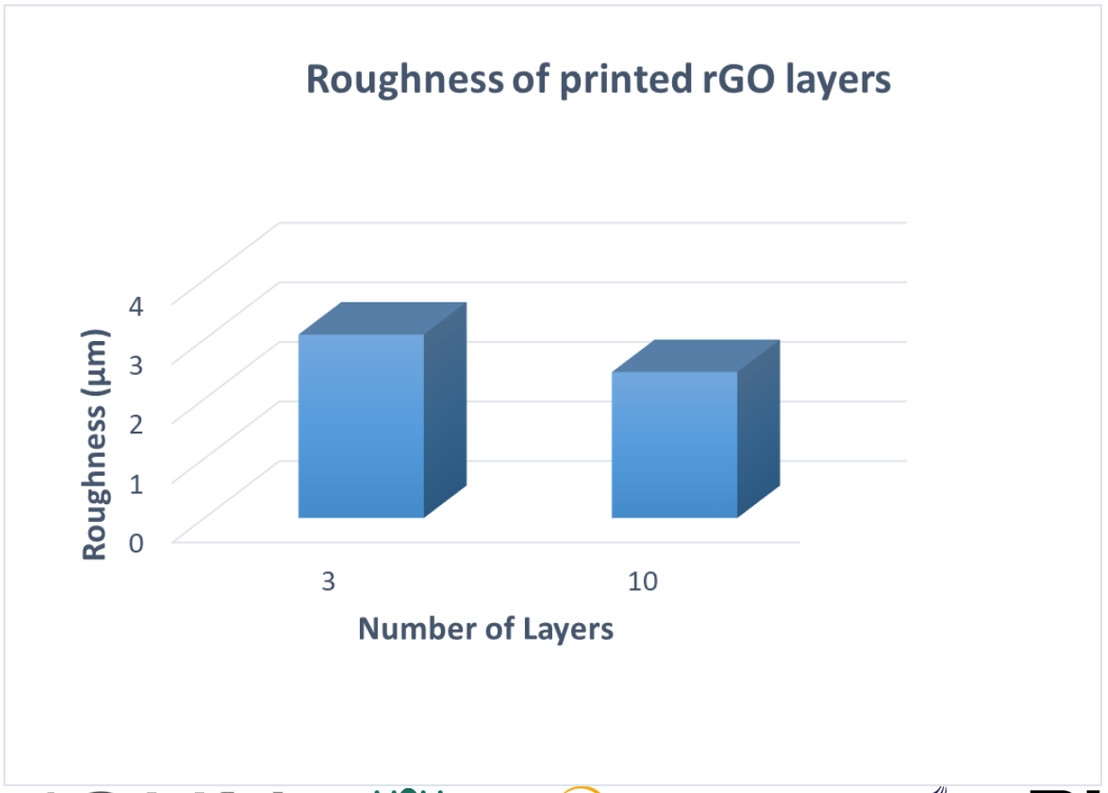
Printing and characterization rGO based layers

- Screen-printing technique
- High-concentration rGO based ink
- PET substrate

Number of layers	Thickness (roughness) (µm)	Sheet resistance (kΩ/sq)	El. Conductivity (S/cm)
3	10.0 (3.1)	38	0.026
10	10.4 (2.5)	22	0.044

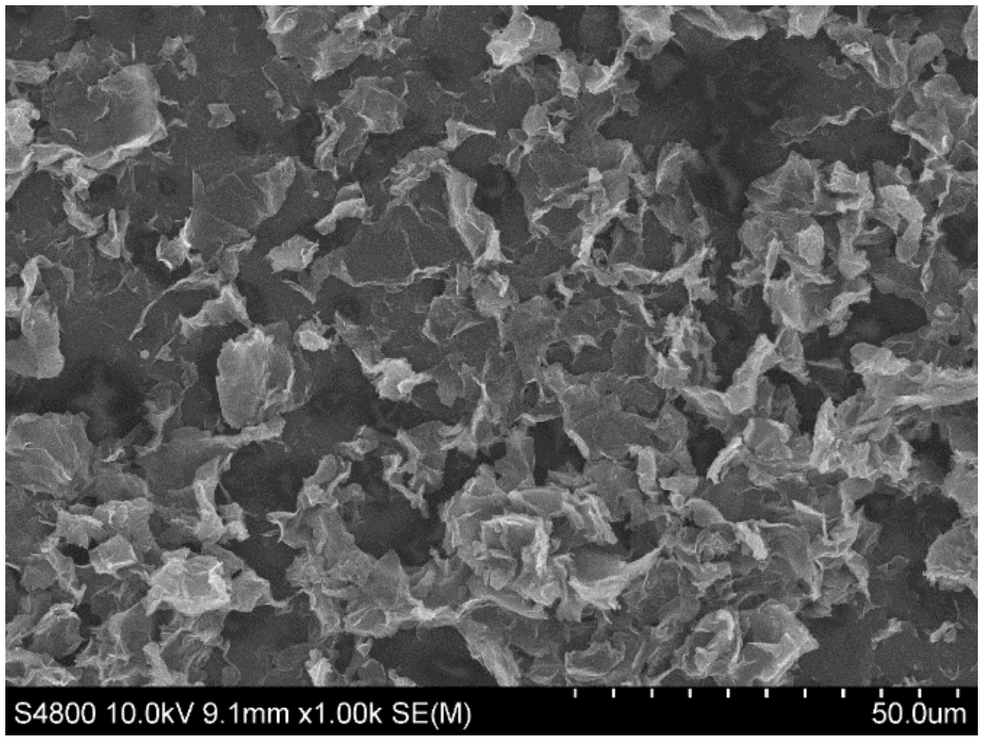


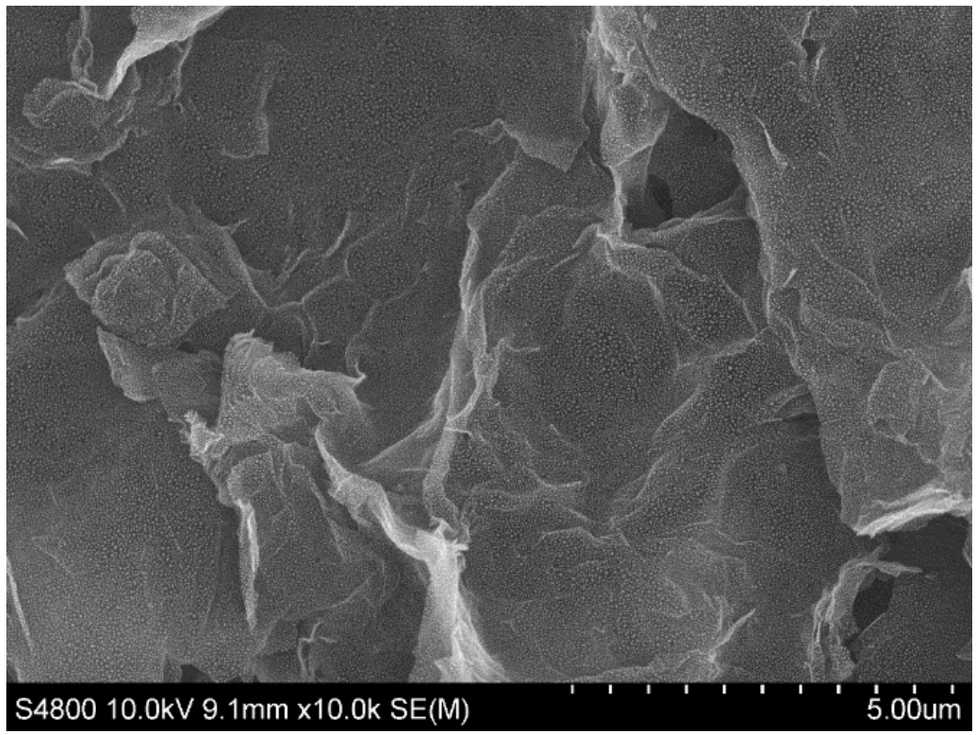




Printing and characterization rGO based layers

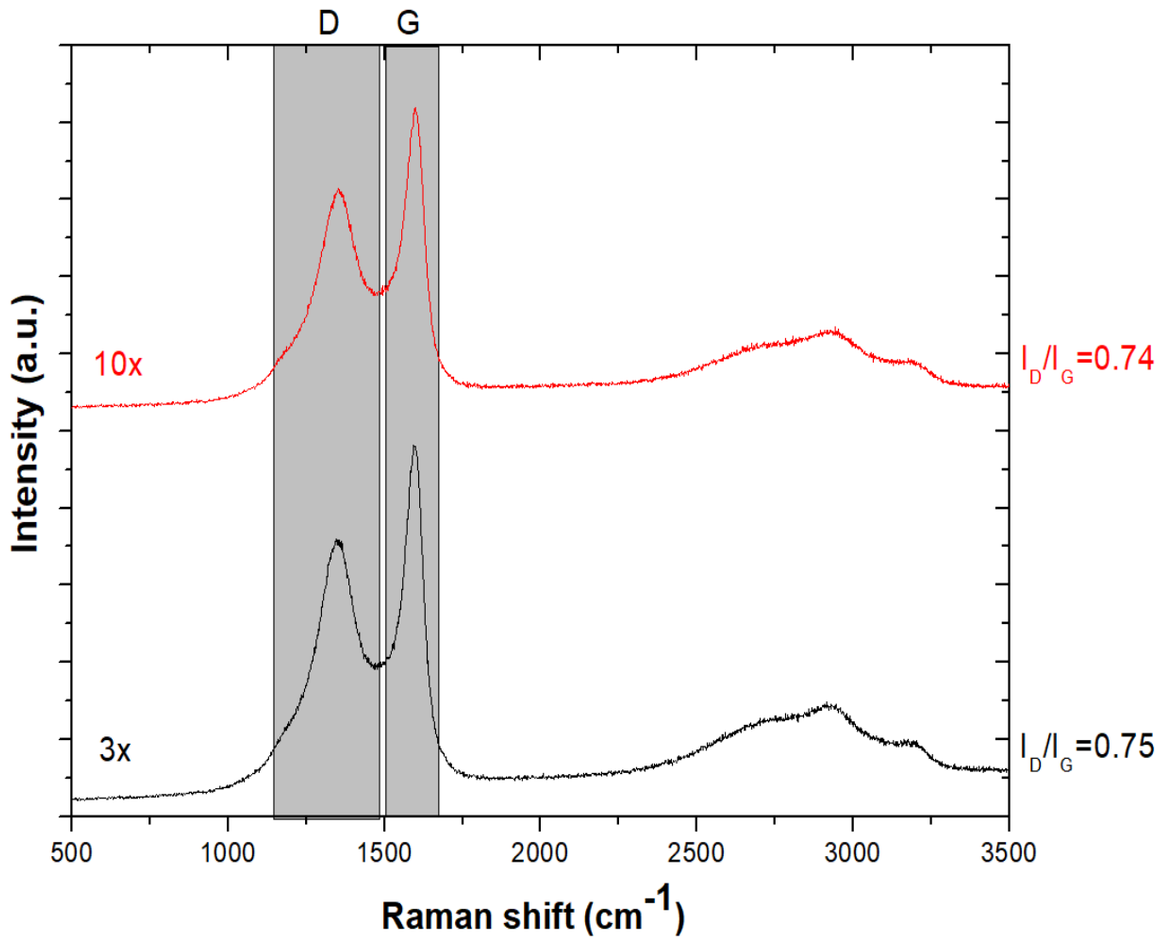
- Screen-printing technique
- High-concentration rGO based ink
- PET substrate





Lamellas-like structures embedded in cellulose-based binder

Printing and characterization rGO based layers



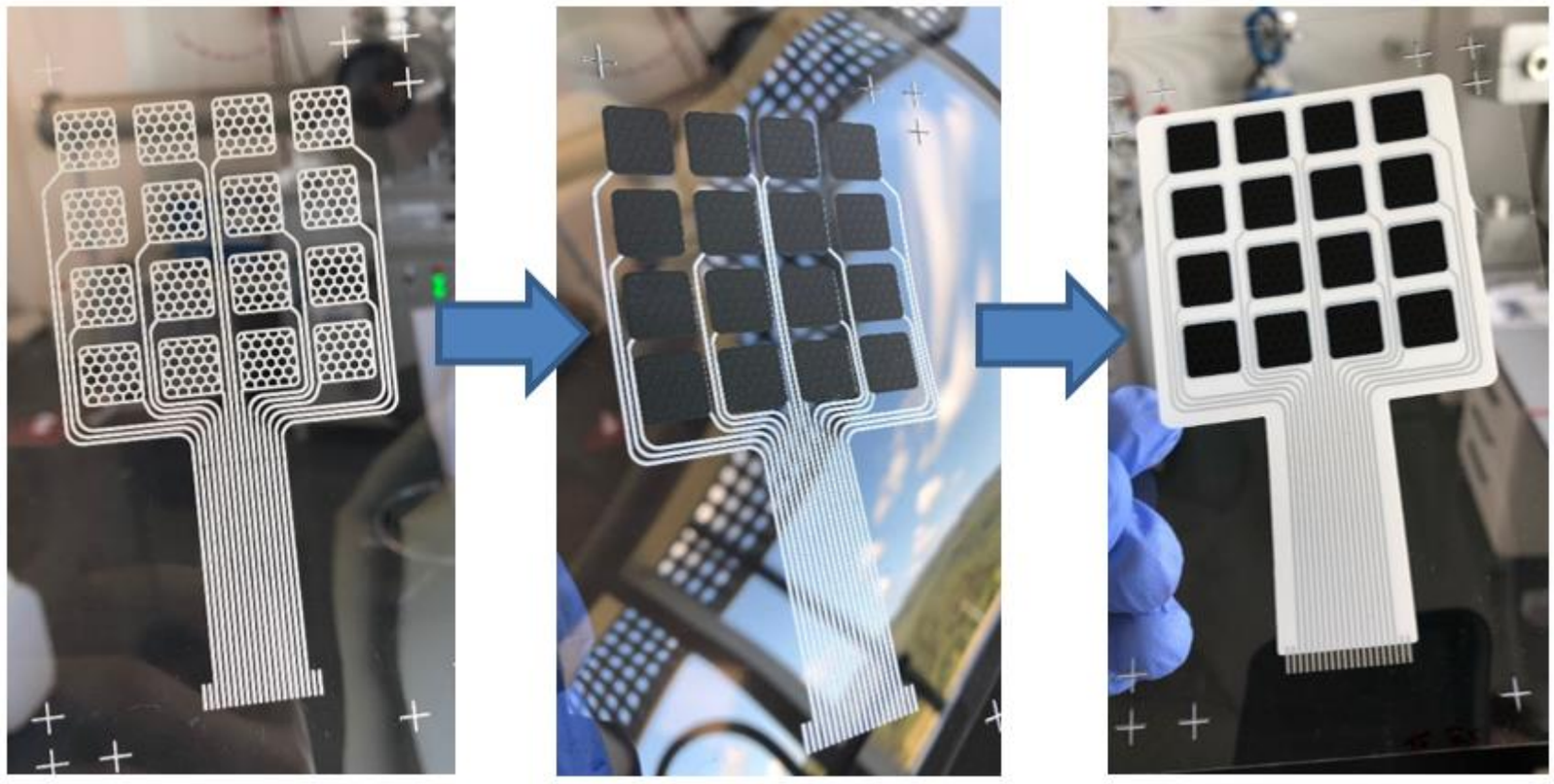
- Two prominent bands at~1350 and~1598 cm-1, corresponding to D (related defects) and G bands
- Structrure of rGO confirmed

*Substrate PET: Significant peak at 1580 cm-1

Alfa demonstrador with commercial inks

- Screen-printing
- Commercial based inks
- PET substrate
- Multilayer

STEP 1 | STEP 2 | STEP 3



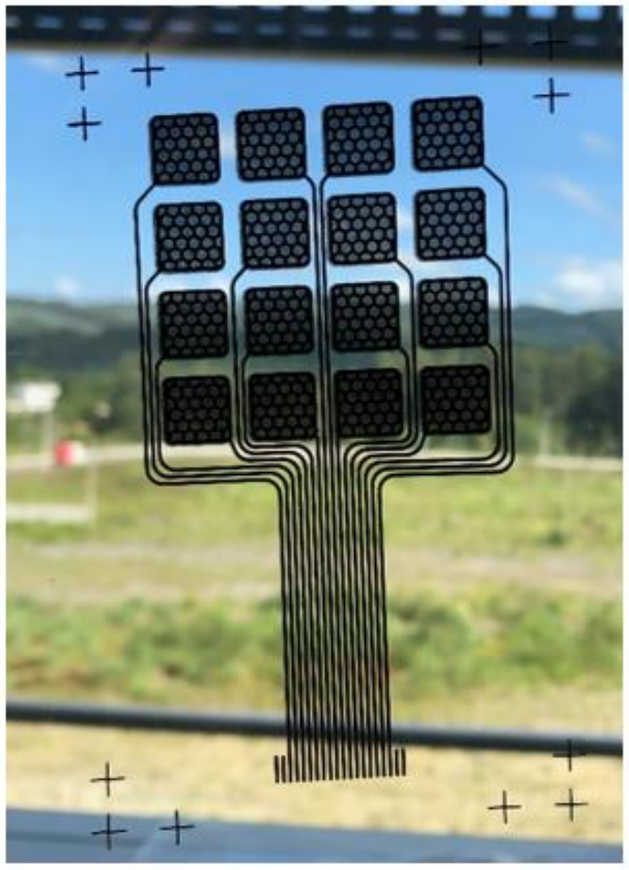
Conductive silver electrodes

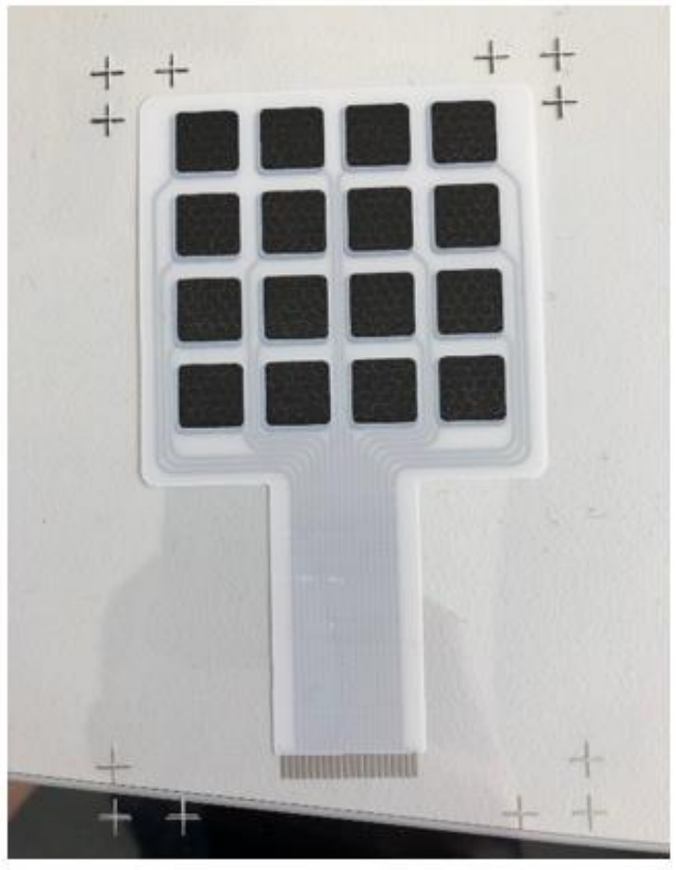
Semi-conductive carbon layer

Dielectric protective layer

Alfa demonstrator with rGO ink

- Screen-printing
- Graphene based inks
- PET substrate
- Multilayer





3. Prospects

Future prospects

- Development of conductive, semi-conductive and dielectric inks with improved bio-compatibility and stretchability for wearables applications

- rGO ink optimization in terms:
  - Adhesion (implementation of other binders: hydrophobic or stretchable)
  - Chemical resistance (stable under in sweat conditions, pH)
  - Electrical conductivity

- Development of semicondcutive inks with improved:
  - Electrical conductivity
  - Chemical resistance/stability
  - Electrochemical behaviour

Thank you!