KTSoftSkills - Soft Skills for Knowledge Transfer - Project n. 2022-1-IT02-KA220-HED-000089663

Co-funded by the European Union

CONFIDENTIAL

Invention Disclosure Form

1. Title of Invention

Stretchable Electronics

2. Inventors (namely the researchers whose intellectual contribution to the design or discovery can be described as inventive, being different from team members whose contributions applied skills but not inventive input. If more than 3 inventors please append additional sheets)[1]

Name (Contact person):	Professor Esticar		
Employer:	University of X Portugal		
Research Group:			
Division:		Work address*:	
Work Phone:			
Mobile Phone:			
Work Fax:			
Work E-mail:			
% inventive contribution:	100%		

Name:			
Employer:			
Research Group:			
Division:		Work address*:	
Work Phone:			
Mobile Phone:			
Work Fax:			
Work E-mail:			
% inventive contribution:			

3. Other Contributors

These are people with whom you may like to share any acknowledgement or returns in the event of successful valorisation of the invention. They are people whose work contributed to the success of the research but who were not responsible for the inventive spark or design of the research. They can include PhD students, technicians, postdocs or other colleagues whom you believe made a material, non-inventive contribution.

Name (Contact person):			
Employer:			
Research Group:			
Division:		Work address*:	
Work Phone:			
Mobile Phone:			
Work Fax:			
Work E-mail:			
% contribution:			

4. Description of invention

Please try to answer the following questions.

4.1. What problem does the invention solve?

Traditional rigid electronics are unable to bend, twist, and stretch without breaking. This severally limits their use. They are also difficult to recycle.

We have developed a novel material composition for printing soft and stretchable electronics at room temperature. This facilitates fabrication of stretchable circuits. The new method allows us to print these circuits at room temperature without the need for thermal sintering, which makes it compatible, with most of the heat sensitive materials.
In addition, we have developed a method that allows integration of microchips into these printed circuits, and subsequent recycling. The electronic circuits can be printed and then subjected to stretching without degradation of performance.

Overall these two technologies contribute toward scalable fabrication of ultrathin stretchable circuits, with applications in wearable biomonitoring, digital health, IoT, and novel generation of energy harvesting films, and displays.

4.2. Do you know of any similar inventions that exist and if so, how does your invention differ?

Stretchable electronics have been under development for some years. However, existing methods for fabrication of stretchable electronics (e.g., conductive elastomers, wavy circuits, EGaIn microfluidics, etc.), tend to be complex, and costly.

Our approach permits scalable fabrication of very resilient stretchable circuits, using low-cost printing techniques. In addition, the printed ink does not require high temperature sintering and is conductive immediately after printing. This is made possible by a novel BiPhasic Composite, which is an alloy of Silver and Eutectic Gallium Indium Liquid Metal (EGaIn).

Unlike other approaches for fabrication of stretchable electronics that require manual fabrication steps, this technique allows for the first-time direct printing of stretchable circuits.

4.3. Abstract or summary of the invention. Please explain the invention in general terms (max. = 100 words)

Our invention is a method for obtaining a flexible printed circuit with a solid-state electric or electronic component. This consists of printing an electric circuit with a conductive flexible polymer-based ink over a polymeric substrate in the solid state, wherein both polymers in the ink and the substrate are reversible solid-gel phase transition polymers; placing the component over the substrate and over the electric circuit; applying an external stimulus that results in a solid to gel transition of the polymeric substrate and ink, such that the component penetrates into the softened substrate, establishing an electrical contact of the component with the printed circuit.

4.4. Keywords (for an overview, see the Annex) maximum of five

flexible printed circuit; conductive flexible polymer;

4.5. Technology Information. Technical description including background, what is new with respect to the state of art, what is the stage of development and further needed improvements (max. = 150 words)

SotA

Methods for fabrication of stretchable circuits have advanced rapidly, but integration of microchips into these circuits remains the biggest challenge of the field, and a main obstacle against scalable fabrication.

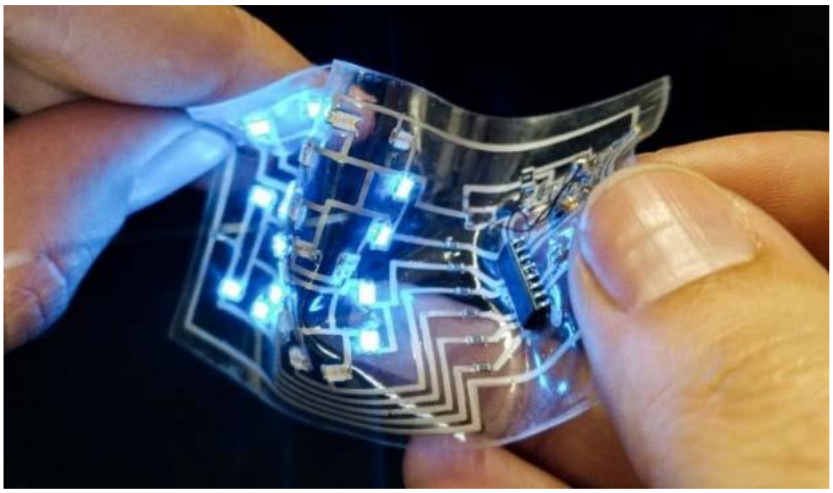
Advances

We have devised a method for fabrication of microchip integrated ultra-stretchable circuits that is able to withstand >600% of strain, over 5x higher than previously reported techniques.

Stage of development

Several proof of concept applications have been developed, and demonstrated that use the process. These includes prototypes of circuits for biostickers for health monitoring, wearable e-textile, printed and stretchable electronic stickers for Human Machine Interfaces, IoT and IoMT devices, Printed Antennas, Printed Batteries, and Supercapacitors. It has been as well demonstrated that the circuits can be recycled after their use, and all components and ink materials can be recovered.

4.6. Additional Information, please attach all available information, for example a summary of the invention being disclosed (Include photographs, drawings, sketches, or any other descriptive material)



4.7. What products and/or processes do you think could be protected by a patent?

We think that we may be able to protect 2 distinct inventions:
1. Fabrication of complex soft-matter circuits in just two steps: ´
i) Digital Printing through a consyctive, stretchable, sinter-free ink, and
ii) Chemical Vapor Exposure for simultanous a.Microchip Integration, b.Microcrack Healing (thus leading to better mechanical performance), and c. autonomous encapsulation without the need for deposition of other materials.
2. The process for recycling of the printed circuits.

4.8. What are disadvantages to the invention or limitations that needs to be overcome?

At the moment we do not see any major problems – the technology is very well developed and working well. We have taken care not to disclose information publically. However, we are not sure how best to enter what is a very broad market e.g. via company who makes specialised inks or to an end user e.g. a company manufacturing smart clothing or medical implants.

5. Information on the intellectual property

MATERIALS	Yes	No	Don't Know
• Have you supplied any material relating to the invention to anyone outside your research group? Please include names of researchers or others outside of your institution.		X	
• If yes, was the material transferred under a Material Transfer Agreement (MTA)? If appropriate, please supply a copy of the MTA or a contact person.			
• Did you use any materials supplied by other researchers or companies to make your invention? • If yes, were the materials supplied under an MTA? If appropriate, please supply a copy of the MTA or a contact person.		X	

When did the idea for the invention first arise? Please indicate who was/were the employer(s)[2] at the time of the invention

Date: 2017 Place: ISCTE
Employer(s): ISCTE

6. Funding sources

Please list all sources of funding that have contributed to the invention

Time Period	**Source** First money stream (University), Second money stream (national funding agencies), Companies, Other sources including EU (please specify)	**What was the relation to the inventive step** (idea, people, materials, etc.)
2017-ongoig	National research grants (FCT) and university internal funding.	All developed under this funding.

7. Public disclosures and confidentiality

	Yes	No
• Has the invention or any part of it been disclosed in a publication, an abstract or any other written materials? If yes, please attach a		X

[2] Please indicate if the employer is different from the employer as indicated on page 1.

copy and write the date of the disclosure on the material. • Will the invention or any part of it be disclosed in a publication, an abstract or any other written materials? If yes, what is the intended date of disclosure?(please be aware that any disclosure may jeopardize the ability to obtain a patent; we advise you to contact the KTO as soon as possible) Intended disclosure date:		
• Is there a draft manuscript detailing the invention? If yes, please attach a copy.		X
• Has this draft manuscript been submitted to a journal or publisher? Please provide details of the publishers, dates of submission and whether or not the publication has been accepted. Planned: Journal name: **ACS Applied Materials & Interfaces** Submission date: under negotiation to coordinate with a patent applications. Outcome/Status: N/A	X	
• Has there been a (poster) presentation or lecture during a public meeting? • Will there be a (poster) presentation or lecture during a public meeting? Intended disclosure date:		X
• Has a third person (outside the institution) been approached about the invention? If yes, who was this person and was the information shared in confidence?		X

8. Commercial interest

	Yes	**No**
• Are you aware of any companies or other users that might be interested in this invention? Do you know of companies or other research groups that could possibly have developed inventions in the same area? If yes, please list names. The market for this invention is very broad. We are not sure where to start e.g.; with an end user namely a company manufacturing smart clothing or medical implants (LG, Samsung, Xiaomi or even Zara to name just a few) or with a company who would make the conductive ink e.g. DuPont.		
• Is the invention related to previous sponsored research projects within your department? If yes, please provide details. • Do you know of any other past or ongoing collaborations and/or agreements with third parties that may be relevant to this invention? If yes, please provide details.		X

9. Signature of inventors

Print Name	Signature	Date
_____	_____	_____
Print Name	Signature	Date
_____	_____	_____
Print Name	Signature	Date