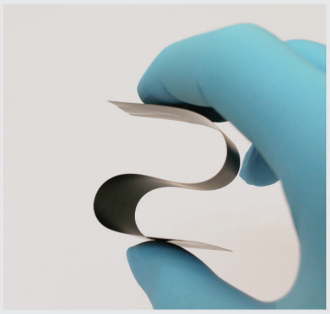
Technology Offer

TT-Ref. 2020-160

Empa
Materials Science and Technology

Ink for 2D and 3D printing of biodegradable flexible electronics



Invention

- **Natural resin and carbon composite based ink**
- **For biodegradable electrically conductive structures**
- **Non-toxic, environmentally safe, cost-efficient, electronically conductive and water-stable when dried**
- **RoHS compliant**

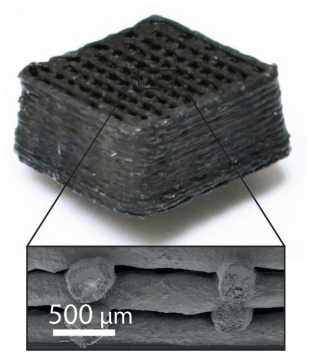
Background

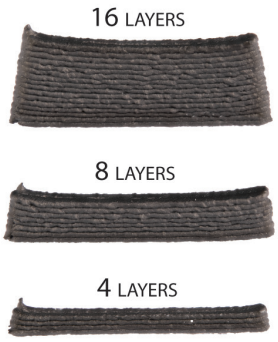
The upturn of the internet-of-things for daily-life objects leads to a massive increase of electronic products with short lifespan. Recycling this new class of electronic devices is particularly challenging due to the wide variety of components and their low economic value.

Current approaches to limit electronic waste use biodegradable conductors with expensive and time-consuming manufacturing processes, and water permeable polymer matrices resulting in precocious electronic failures without a series of encapsulation layers. Using encapsulants complicates the manufacturing process and often impede the use of 3D printing, thus preventing the integration of active components with structural components using the whole accessible volume as well as manufacturing in a one step procedure.

Advantages

The above-mentionned challenges have been solved using shellac as a matrix and dispersed carbon black and graphite flakes particles, resulting in a disposable, water stable and highly electrically conductive composite. The ink is shear-thinning and allows to flow liquid like in the extrusion nozzle of filament based 3D printing techniques such as robocasting or Direct-Ink-Writing. The fine-tuned ratios between solvent, binder and rheology modifier leads to a specific yield shear stress and allows for complex patterning. The ink is RoHS compliant (restriction of hazardous substances in electrical and electronic equipment).





Applications

The gel compositions will enable shape retention when 3D printed, display high electrical conductivity, offer metal-free, non-toxic and sustainable alternatives to metal-based electrodes, with water stablility when printed and dried.
It can be particularly used for preparing electronics devices, especially low-cost disposable electronics, and can be featured as sustainable bio-sourced current collector for batteries, as metal-free antennas for near-field-communication systems and as capacitive sensor electrodes for smart packaging and biosensors devices.

Ownership

Empa, Swiss Federal Laboratories for Materials Science and Technology, Überlandstrasse 129, CH-8600 Dübendorf; PCT application PCT/EP2022/050716, filed in January 2022

References

Fully 3D Printed and Disposable Paper Supercapacitor. Xavier Aeby, Alexandre Poulin, Gilberto Siqueira, Michael K. Hausmann and Gustav Nyström. *Advanced Materials, Vol. 33, Issue26, May 14, 2021*. DOI: 10.1002/adma.202101328.
Versatile carbon-loaded shellac ink for disposable printed electronics. Alexandre Poulin, Xavier Aeby, Gilberto Siqueira, Gustav Nyström. *Scientific Reports, Vol. 11, p1–9. November 24, 2021.* DOI: 10.1038/s41598-021-03075-4

Keywords

shellac, carbon, printed electronics, disposable electronics, sustainable electronics, direct ink writing, robocasting, printing, non-toxic, metal free

Contact

Empa, Technology Transfer
Dr Katharina Zwicky, katharina.zwicky@empa.ch
Phone +41 58 765 49 27

Technical Information
Dr Gustav Nyström, gustav.nystroem@empa.ch
Phone +41 58 765 45 83

Empa is an interdisciplinary research and service institution within the ETH Domain covering selected fields of materials science and technology development including important environmental issues. Empa's R&D activities focus on the requirements of industry and the needs of society, thus linking research to engineering, and science to industry and society. As a result, Empa is capable of providing its partners with customized services and solutions that not only enhance their innovative edge, but also help to improve the quality of life for the public at large. Safety, reliability and sustainability of materials and systems are cross-sectional topics and a hallmark of all Empa activities. As such, Empa plays a key role in Switzerland's research and innovation landscape.

Empa
Materials Science and Technology

Empa

CH-8600 Dübendorf
Überlandstrasse 129

Telefon +41 58 765 11 11
Telefax +41 58 765 11 22

CH-9014 St. Gallen
Lerchenfeldstrasse 5

Telefon +41 58 765 74 74
Telefax +41 58 765 74 99

CH-3602 Thun
Feuerwerkerstrasse 39

Telefon +41 58 765 11 33
Telefax +41 58 765 69 90

www.empa.ch