Thin, Flexible, and Printable Supercapacitors and Batteries (FlexPower)

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Printed electronics are all the rage, mostly passive, *i.e.,* without energy storage devices (*e.g.,* batteries and supercapacitors). However, the market for active battery-powered smart devices, such as active RFID tags, IoT sensors, and smart cards, has grown rapidly (> €100 billion market value, CAGR 10-15%) due to higher security, real-time tracking and updating, and less dependence on reader power, and has led to the rapid growth of the printed and thin-film battery market (CAGR 24%).

Currently, these active smart objects are powered mainly by primary batteries such as Li-MnO_2 and Zinc batteries. However, these batteries require frequent replacement (6-12 months). On the other hand, thin-film rechargeable lithium-ion batteries (LIBs) require stringent moisture-free manufacturing, which is not easily translated to printing technologies, and their chemistry is often considered hazardous and flammable [1]. In addition, the raw materials for LIBs (*e.g.,* Lithium, Cobalt, Nickel) are on the EU list of critical raw materials, which affects their sustainability.

FlexPower commercializes thin film, printed supercapacitors, and rechargeable zinc batteries (**Figure 1**) based on graphene electrodes and water electrolytes [2,3]. FlexPower's technology is non-flammable and non-toxic, and all components of the device are disposable except for the polymer (*e.g.,* PET) cell housing. In addition, the raw materials are not on the EU list of critical raw materials, ensuring the sustainability and independence of the technology's value chain.

References

[1]. Rassek, P., Wendler, M. and Krebs, M. (2018). Industrial Perspective on Printed Batteries. In Printed Batteries (eds S. Lanceros-Méndez and C.M. Costa)

[2] G. Wang, X. Feng, A. Shaygan Nia. Electrochemical component and its use, DE102021115802A1

[3] D. Sabaghi, X. Feng, A. Shaygan Nia. Electrochemical component and its use, DE102023128070.8

[4] X. Feng, K. Müllen et. al. Process for encapsulating metals and metal oxides with graphene and the use of these materials, US8611070B2

Figures

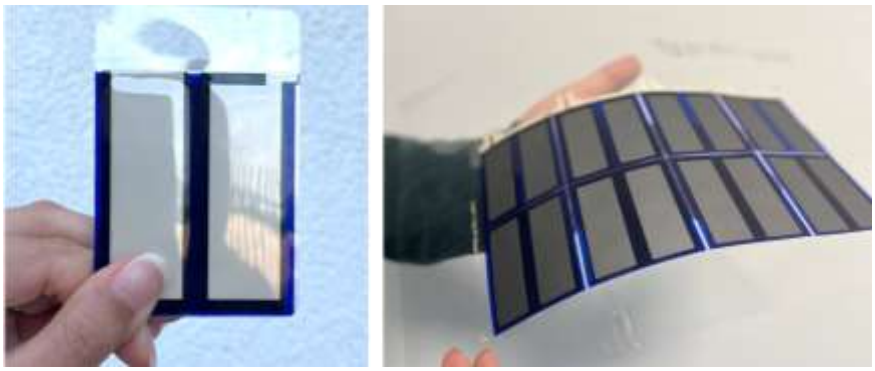

Figure 1: FlexPower Printed Thin Film Graphene-based Supercapacitors and Batteries