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Invited talk:

Miniaturization of energy autarkic sensor systems by structure integrated energy storage systems for use in robotics, satellite and aircraft applications

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As part of digitalization in all sectors, mobile systems require self-sufficient and smart sensors for decentralized operation of all processes, wireless data collection and transfer. A sensor is self-sufficient and smart, if it supplies itself with power, offers diagnostic functions and has digital interfaces that enable integration into the operational environment. Thus, self-sufficient, energy autarkic sensors and the associated electronics combine energy generation and management systems, data acquisition and transmission units and can be applied structurally compliant manner in the form of a “smart sensor patch“ to record the electrical, mechanical and other changes. The demand for peak surge power storage devices in daily life of industrialized and modern societies increases rapidly as the applications of electronic materials increases in various fields such as flexible electronic textiles, wearable and portable electronics/gadgets, sensor operations in robotics, aerospace, satellites, aircraft as well as automotive applications

Clean energy can be harvested from renewable and natural resources. The otherwise wasted energy such as thermal, vibration, kinetic and movement can be recuperated to electrical energy. Due to irregular nature of these energy resources, electrical energy storage systems (ESSs) are extremely desirable to store the generated or harvested energy every second, thus resulting in continuous sensor operation and data collection. In order to enable these applications, it is required that EESs are high performant, low-cost, lightweight and miniaturized. Among various types of electrochemical ESSs, supercapacitors (SCs) are the most promising candidates to be applied for these purposes.

To date, the use of market available SCs could not meet the energy expectations of such demanding areas due to their electrolyte leakage, low voltage application, low capacity, low cycle stability, poor rate-capability unreliable mechanical flexibility and inconveniency for system integration. The recent research efforts in our laboratories are focused on the development of laser-induced graphene (LIG)-based micro-supercapacitors constructed as interdigitated electrodes that exhibit good performance with a very lower weight and thickness, making their integration into devices and systems easy to achieve. Further work is directed into their integration with the energy harvesters and electronics. Structure embedded SC-cells with lightweight and leakage-free concepts are finding application at solar operated low-orbit satellites and aircraft components.