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Editorial: Organic Electronics: Future Trends in Materials, Fabrication Techniques and Applications

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Editorial on the Research Topic

Organic Electronics: Future Trends in Materials, Fabrication Techniques and Applications

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Since the discovery of the conducting properties of polyacetylene by the scientists Shirakawa, MacDiarmid and Heeger in 1977 [1–3], which led them to the Nobel Prize in Chemistry in 2000, organic electronics has been deeply investigated by the research community, emerging as a promising technology for the conception and realization of innovative and smart devices. Indeed, the unique properties of organic small molecules and polymers, such as their easy processability from solution, possibility of deposition at low temperature, over large areas and by means of low-cost techniques compatible with roll-to-roll printing processes, make them ideal candidates for the development of a novel platform for advanced opto- and micro-electronic devices and sensing systems, easily scalable from lab to industrial prototypes [4]. Moreover, the high electronic performances achieved thanks to recent progress in molecular tailoring [5] and device conception and fabrication are pushing technology of organic electronics even closer to the marketplace for a large plethora of applications.

Despite the great potential of organic electronics explored in the last 20 years, light emitting diodes are the only organic devices commercialized so far. Organic electronics are expected to impact other research fields, such as solar cells [6, 7], UV-vis [8] and ionizing radiation detectors [9, 10], memories [11], chemical and biological sensors [12], etc. However, several challenges have still to be addressed, which are feeding the research activity of the last years.

The current and future trend of organic electronics has been clearly intercepted by the papers reported in this research topic, as shown by the exponential growth of the number of articles published in the field in the last 10 years. The most promising applications of organic electronic devices encompasses device tools and items for Internet-of-Things (IoT) systems, specifically targeting wearable electronics for energy harvesting and healthcare applications.

Alves and co-workers here propose graphene-based triboelectric nanogenerators, whose components are fabricated by low-cost, easy fabrication, and fast methods, i.e., shear exfoliated graphene electrodes and an active layer composed by graphene combined with polydimethylsiloxane (PDMS) deposited by spin-coating. The exfoliated electrodes exhibit sheet resistance as that of chemical vapor deposited graphene thin films, corresponding to excellent device electrical power generation, i.e., tens fold higher than similar devices with aluminum electrodes. This result establishes the employment of shear exfoliated graphene back electrodes as an effective and reliable alternative metallic layer in triboelectric nanogenerators. The authors demonstrate excellent performances of shear exfoliated graphene also as triboelectric layer combined with PDMS and deposited by spin coating, further assessing, and paving the way for the potential exploitation of carbon-based components to be integrated by solution deposition techniques in wearable and textile energy harvesting and sensing systems.

With a similar aim, Tessarolo and co-workers here present a textile moisture sensor to monitor the wounds' healing process. The authors develop an e-textile moisture impedance sensor based on electrodes made of the conductive polymer poly (3, 4-ethylenedioxythiophene): polystyrene sulfonate (PEDOT:PSS) screen-printed onto a gauze and embedded into a commercial bandage. The device is interfaced with an RFID read-out chip, allowing a real-time, wireless, and fully passive read-out. Such a smart textile sensor demonstrates to be able to estimate the exudate volume, and thus permits both the identification of the saturation regime of the bandage and to discriminate between *dry* and *wet* status of the wound. The real-time monitoring of moisture would avoid the usual removing of the dressing and would allow the implementation of personalized therapy for optimal wound care and tissue regeneration. This work strongly contributes towards the implementation of organic electronic devices as innovative, easy, low-cost, and disposable tools for healthcare application.

Besides solution processes, an alternative promising approach to implement e-textile devices is the fabrication of functional fibers as active elements to be sewn in smart garments. This approach has been followed by Lenord and co-workers, who report here stretchable electrodes and electrochemical transistors based on conductive PEDOT: tosylate (PEDOT:Tos) nanofibers. The fabrication of the devices consists in a combination of electrospinning and printing techniques, which are processes compatible with industrial upscaling, and thus they are appealing for production-scale fabrication. The authors show how high conductivity and suitable mechanical flexibility of electrospun mats can be reached by controlling the processing time, fiber morphology and junction density. The high potential of organic conductive nanofibers, for stretchable and wearable electronics is strengthened by this study, thanks to the excellent endurance of their electrical and mechanical properties here demonstrated.

Concluding, all the reports of this research topic witness the peculiar challenge of organic electronics for the development of new sensors and devices for novel portable, wearable and textile systems, in the area of the IoT, with a particular focus on multi-parameter and real-time monitoring for healthcare applications.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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