Extended Abstracts of the 2018 International Conference on Solid State Devices and Materials, Tokyo, 2018, pp7-8

Skin-Inspired Electronics

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Abstract

Skin is the body's largest organ, and is responsible for the transduction of a vast amount of information. This conformable, stretchable, self-healable and biodegradable material simultaneously collects signals from external stimuli that translate into information such as pressure, pain, and temperature. The development of electronic materials, inspired by the complexity of this organ is a tremendous, unrealized materials challenge. However, the advent of organic-based electronic materials may offer a potential solution to this longstanding problem.

My group has been working on understanding of the fundamental design principles of new electronic materials that have skin-like properties, such as stretchability, self-healing ability and biodegradabaility while maintaining excellent electronic properties. We realized artificial skin with sensitivity and stretchability comparable to that of human skin. We demonstrated artificial mechanoreceptors and artificial nerve systems. In turn, the basic inventions of materials and devices enabled a new generation of skin conformal electronics that can be used for health monitoring wearables, wireless and biodegradabale implantable sensors for tendon repair and neuroprostheses.

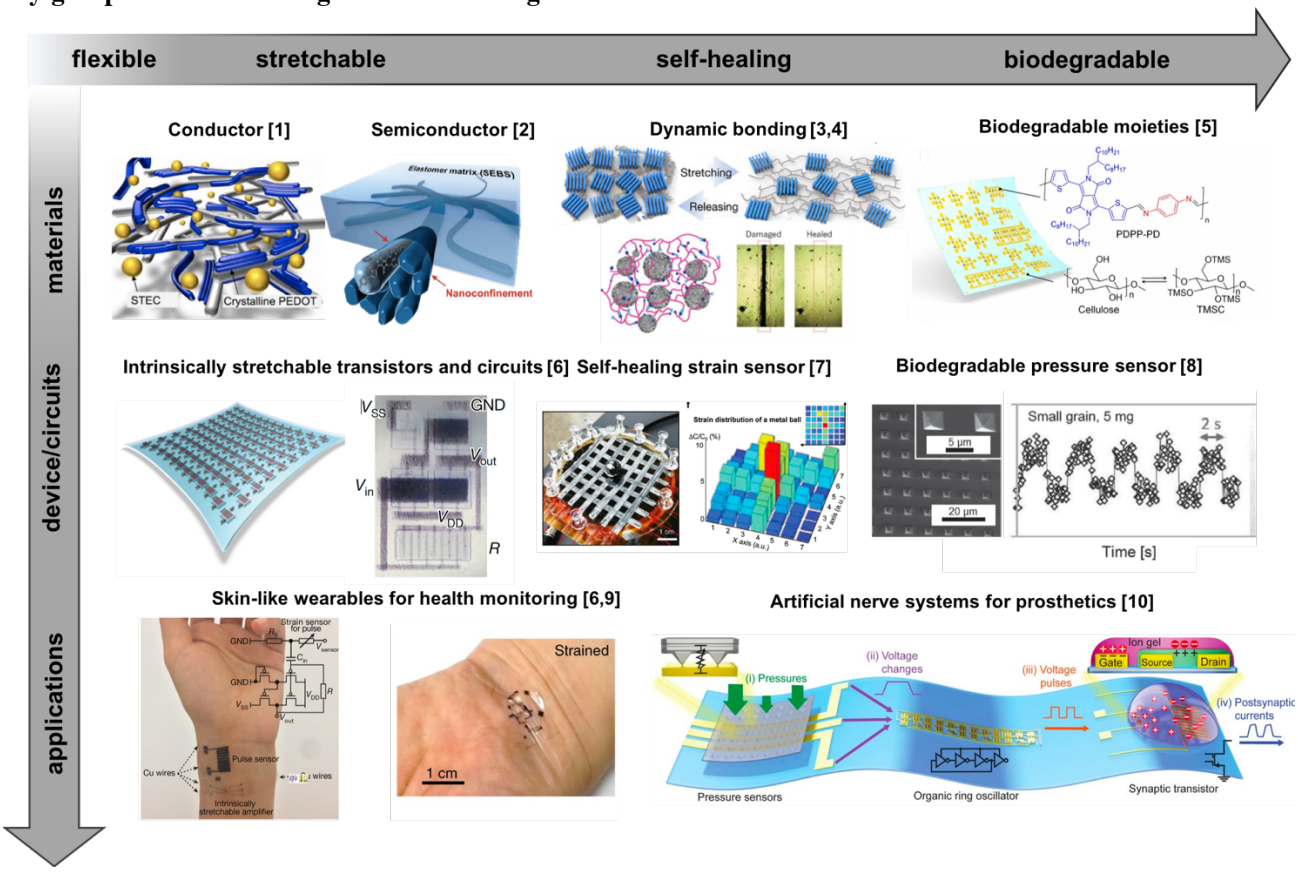

Fig. 1 Our research and developments for skin-inspired electronics, which imparts skin-like properties (flexibility, stretchability, self-healing property, and biodegradability) onto electronics, by starting from the developments of polymer electronic materials with these properties, to the constructions of functional devices and circuits, and finally to the emerging applications for healthcare wearables, medical implants, and neuroprosthetics. [1-10]

1. Introduction

Future electronics will take on more important roles in people's lives. They need to allow more intimate contact with human beings to enable advanced health monitoring, disease detection, medical therapies, and human– machine interfacing. However, current electronics are rigid, nondegradable and cannot self-repair, while the human body is soft, dynamic,

stretchable, biodegradable, and self-healing. Therefore, it is critical to develop a new generation of electronic that incorporate skin-like properties, including stretchability for conformable integration, minimal discomfort and suppressed invasive reactions; self-healing for long-term durability under harsh mechanical conditions; and biodegradability for reducing environmental impact and obviating the need for secondary device removal for medical implants. These demands have fueled research and technological developments of a new generation of electronics, "skin-inspired electronics".

2. General Instructions

Our group's research in skin-inspired electronics starts from the developments of new generations of electronic materials, primarily composed of polymers and polymer composites with both high electrical performance and skin-like properties. These are based on new chemical design or physical engineering concepts for the polymeric materials. Then, with new device designs and fabrication approaches, we have been utilizing these new class of materials to build electronic devices and circuits, which possess functions and properties both similar to human skins. These technological developments are further enabling us to demonstrate new applications for electronics, including skin-like wearables for health monitoring, biodegradable implants for tendon repairs, artificial mechanoreceptors, artificial nerve systems, etc.

3. Conclusions

Our research has established basic material design principles, fundamental understandings, devices structures, fabrications, and emerging applications for skin-inspired electronics, which paves the way for a new generation of electronics that can be seamlessly integrated with human bodies.

Acknowledgements

I would like to express sincere thanks to all my present and past group members, collaborators, and funding agencies for their significant contributions to this research.

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