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Triboiontronics based on dynamic electric double layer regulation

Liqiang Zhang¹ and Daoai Wang^{1,*}

The regulation and application of ion carriers in the electric double layer is challenging. In this issue of *Matter*, Wei et al. propose a concept of “triboiontronics” based on triboelectrification regulation, breaking through the barrier of ion arrangement regulation through electronics with higher energy transfer efficiency.

Designing an effective way to regulate the nervous system's information is challenging. Traditional silicon-based energy devices are based on transporting electrons and/or holes, whereas biological nervous systems rely more on ions.¹ The conduction of nerve impulses is achieved by ion transport in the electrical double layer. The electric double layer of the interface contains charge carriers composed of electrons and ions, which is closely related to triboelectrification.^{2–5} Regulation of electric double layer properties by triboelectrification suggests a possible approach to this problem.

In a recently published article in *Matter*, Wei and coworkers addressed this issue by dynamically regulating ion charge carriers in the electric double layer at the insulator-liquid interface through

contact electrification and proposed the concept of “triboiontronics” to realize efficient energy harvesting and information transmission.⁶ The electrical double layer structure of the liquid interface has been studied for more than a century, but how to fine-tune it remains a challenge. The work of Wei's group has been a successful attempt to resolve this issue with a fabulous imagination.

Firstly, a novel direct-current triboiontronic nanogenerator (DC-TING) was devised, which can realize the regulation of ion charge density in the diffusion layer of the electric double layer through solid-liquid contact electrification induced by charged deionized water mist. Moreover, DC-TING based on the *in situ* ion charge supplement strategy can effectively avoid the depletion of induced charge on the

surface of the solid friction layer, thus significantly improving its peak power density compared with other DC triboelectric nanogenerators.

This work constructed a bidirectional electric field to dynamically regulate the charge distribution in the dense layer of the electric double layer through solid-solid contact electrification. It can regulate the ion charge polarity in the diffusion layer through remote control, building a bridge between electronic information and ion information of organisms, which is a fantastic idea. Based on this, a bionic neural circuit for triboiontronics was constructed. It could store the physical contact information in contact electrification into the ion charge polarity information in the diffusion layer and convert it into the corresponding electronic information.

Considering the mechanism of interfacial charge generation and the properties of the electric double layer, contact electrification is closely related to the properties of the electric double layer. As shown in [Figure 1](#), the properties of the electric double layer have been

¹State Key Laboratory of Solid Lubrication, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou 730000, China

*Correspondence: wangda@licp.cas.cn
<https://doi.org/10.1016/j.matt.2023.10.008>



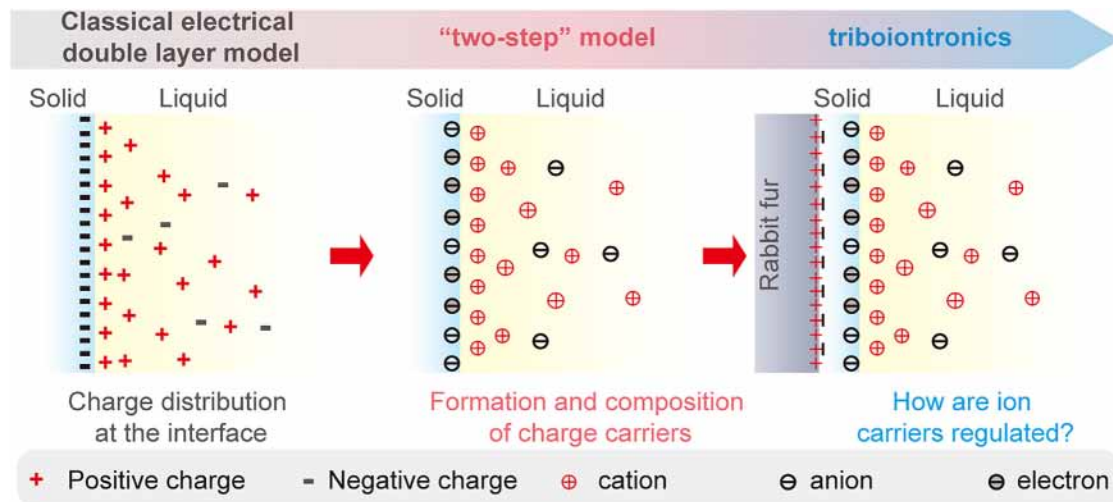


Figure 1. The schematic of the interfacial electrical double layer and ion carrier regulation via contact electrification

further revealed scientifically in recent years, and Wei et al.'s work has lifted the curtain on ion carrier regulation. Not only can it be used as a new "probe" for the study of electric double layer properties, but it also gives rise to a new interdisciplinary research direction of triboiontronics, which has huge potential for future research.

Overall, Wei et al. have built a bridge to the electron-ion-regulated neural information flow from the electron double layer nature of the interface, providing a research idea for interface property control in the new mode, biological sensors, brain computer interface control, etc. Triboiontronic nanogenera-

tors may gain more research interest in efficient energy harvesting, precise control of the interfacial electrical double layer, and rapid regulation of the biomimetic nervous system.

DECLARATION OF INTERESTS

The authors declare no competing interests.

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