A non-contact wearable device for monitoring epidermal molecular flux

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Existing wearable technologies rely on physical coupling to the body to establish optical[1,2], fluidic[3,4], thermal[5,6] and/or mechanical[7,8] measurement interfaces. Here we present a class of wearable device platforms that instead relies on physical decoupling to define an enclosed chamber immediately adjacent to the skin surface. Streams of vapourized molecular substances that pass out of or into the skin alter the properties of the microclimate defined in this chamber in ways that can be precisely quantified using an integrated collection of wireless sensors. A programmable, bistable valve dynamically controls access to the surrounding environment, thereby creating a transient response that can be quantitatively related to the inward and outward fluxes of the targeted species by analysing the time-dependent readings from the sensors. The systems reported here offer unique capabilities in measuring the flux of water vapour, volatile organic compounds and carbon dioxide from various locations on the body, each with distinct relevance to clinical care and/or exposure to hazardous vapours. Studies of healing processes associated with dermal wounds in models of healthy and diabetic mice and of responses in models using infected wounds

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The skin forms our primary interface with the environment, and the movement of chemical species into and out of the skin surface can substantially influence health. These fluxes include water, an abundant species in the body and the atmosphere, as well as volatile organic compounds (VOCs), carbon dioxide (CO_2) and other medically important compounds[9–12]. Imbalanced outward water-vapour fluxes often indicate dysfunction in cutaneous homeostasis[9], whereas certain pathologies and infections at wound sites can be linked to the emissions of vapourized chemicals[10,11]. Inward fluxes of substances provide valuable insights into the effects of atmospheric chemicals on health[13]. Existing wearable devices use microfluidic networks for precise monitoring of the time-dependent flow of liquids, such as sweat[14,15], from the surface of the skin; but these and other approaches do not apply to gases. We present a compact, wireless platform designed for continuous, quantitative monitoring of gaseous fluxes into and out of the skin at sequential time points through repeated cycles of transient measurements. The capabilities of the platform derive from the time-dependent modulation between open and closed modes of a defined microclimate immediately adjacent to the skin, in contrast to existing static systems[16–19]. The non-contact proximity operation principle contrasts with that of conventional wearable devices that require direct physical contact with the body. This technology can provide unique insights for clinical decision-makers managing conditions such as dermatological diseases and dermal wounds, as well as an improved understanding of underlying pathophysiologies. Moreover, the device enables the monitoring of hazardous atmospheric chemicals that enter the body through the

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