Exploring Moisture Management in Wearable Device Adhesive Selection

Wearable device material selection requires designers to choose the right adhesives for use in their specific device application. It can be helpful to have a basic understanding of the adhesive materials that serve as wearables' building blocks. There are two overarching classifications that provide a helpful framework for the decision-making process.

1. Adhesive purpose: At a high level, there are two primary types of adhesive materials used in skin-worn devices—the kind that adhere the device to the patient and the kind that hold elements of the device together. The former are called skin-contact layer adhesive materials and the latter are known as tie-layer materials.

2. Adhesive fluid handling method: The second big-picture factor to consider is how the adhesive material will manage bodily fluids, such as sweat and oils. For wearables requiring extended wear times, moisture management is probably the single most important material performance characteristic. It affects both functionality and patient comfort, which ultimately drive whether the device will be worn as intended and prescribed. There are two primary forms of moisture management:

- **Moisture-vapour transmission**: Tiny holes in the adhesive material allow moisture to move from the skin and out through the material to evaporate. Materials leveraging this approach are referred to as breathable.
- **Fluid absorption**: The material absorbs moisture, holding it away from the skin so that it doesn't cause irritation or maceration. The material contains ingredients that absorb the majority of the exudate (fluids), forming a gel within the material's structure.'

Throughout the wearable material selection process, it's essential to evaluate the interplay between these core factors. Some skin-contact layer adhesives work well with some tie layer materials, and others are incompatible. Their compatibility often is directly related to their moisture management method. For example, if a device maker wishes to use a breathable skin-contact adhesive, the manufacturer also should be sure to use a porous tie layer material, or at least to include air channels in the design. Otherwise, fluids will be trapped, and unable to evacuate and evaporate properly.

When vapour transmission is the preferred fluid handling approach, acrylic adhesive materials are a popular choice for the skin-contact layer. Acrylic adhesives can be coated onto thin foams or soft non-woven carrier materials. They are very stable, with few residual components that could leech into the skin over extended wear times. For the tie layer, there are breathable transfer (or free film) tapes as well as some new double-coated tapes that provide reliable fixation for device components, all while complementing the breathability of the skin-contact layer.

Some wearable device designs simply do not allow for moisture vapour transfer. Perhaps there is an airtight rigid plastic casing required to protect the device's sensors and battery. Or, in other situations, the target patient population may have extremely fragile or damaged skin, prompting the use of a gentle, silicone-based adhesive gel or absorbent hydrocolloid. In some cases, if a non-breathable device structure has to be used, a specialist converter can perforate certain materials to generate some breathability. When there is no means of ventilation, another solution is to position an absorbent hydrocolloid skin-contact material layer as an island beneath the sensor housing. This would help capture moisture and keep tissue comfortable.

Reference: 1. Prakash, Deepak. "Designing Wearables: How to Make Sense of Your Material Options." Medical Design & Outsourcing, 9 Mar. 2018, www.medicaldesignandoutsourcing.com/designing-wearables-material-options/.

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