Microfluidics for Wearable Electronics

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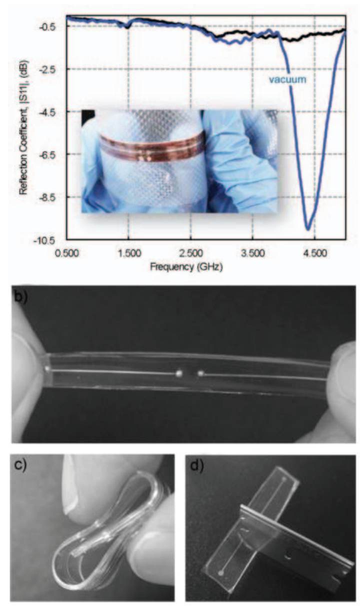
Taking cues from the body itself, the inherent flexibility of liquids which define microfluidic devices make them well-suited to wearable electronics. We present current research outlining techniques which hold promise in this field.



Recent efforts have demonstrated "reconfigurable circuits formed by liquid metal shaping with <10 pounds per square inch (psi) Laplace and vacuum pressures," which manipulate gallium alloys into microreplicated trenches by means of vacuum supplied by an external pump. This includes a flexible, switchable 4.5 GHz antenna. Dickey et al. have used the same liquid metal in conjunction with soft elastomers to fabricate "fluidic dipole antennas that are reconfigurable, reversibly deformable, and mechanically tunable," with radiation efficiencies equivalent to copper. These antennae have strain-dependent resonant frequencies, and a self-healing effect due to qualities of the liquid metal and elastomer casing. Efforts are underway at the University of Cincinnati to utilize voltage-induced actuation ("Electrowetting") of liquid metal in order to digitally reconfigure liquid metal structures.

In order to interface with the body for long periods of time, as required in many biosensor applications, wearability is a necessary device property. Our group has recently demonstrated "a complete [RFID] wireless sensor with wearability comparable to a simple Band-Aid® that is low cost, robust, communicates with smart phones and exhibits a design which automatically lends itself to maximum time-resolved readings of sweat." The patch stimulates sweat and performs potentiometric sensing of solutes in sweat and surface temperature with anticipated applications in "hydration and heat-stress monitoring through electrolyte balance (e.g., Na^+, K^+) for athletes, military personnel, first-responders, and others working in extreme conditions." The patch is inductively powered by smart phone RF signals, and wearability has been shown up to 7 days.