How gold binds to silicone rubber

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Flexible electronic parts could significantly improve medical implants. However, electroconductive gold atoms do not easily bind to silicones. Researchers from the University of Basel have now modified short-chain silicones to build strong bonds to gold atoms. The results have been published in the journal *Advanced Electronic Materials*.

Ultra-thin and compliant electrodes are essential for flexible electronic parts. In medical implants, the challenge lies in the selection of the materials, which have to be biocompatible. Silicones were particularly promising for application in the human body because they resemble the surrounding human tissue in elasticity and resilience. Gold also presents excellent electrical conductivity but only weakly binds to silicone, which results in unstable structures.

An interdisciplinary research team of the Biomaterials Science Center and the Department of Chemistry at the University of Basel has developed a procedure that allows binding single gold atoms to the ends of polymer chains. This procedure makes it possible to form stable and homogeneous two-dimensional gold films on silicone membranes. Thus, for the first time, ultra-thin conductive layers on silicone rubber can be built.

The approach involves the thermal evaporation of organic molecules and gold atoms under high-vacuum conditions, resulting in ultra-thin layers. Secondly, their formation from individual islands to a confluent film can be monitored with atomic precision by means of ellipsometry. Using masks, the resulting sandwich structures can convert electrical energy into mechanical work similar to human muscles.

Energized silicone rubber

In the future, these dielectric artificial muscles could serve as pressure sensors and even be used to harvest electrical energy from body movement. For this purpose, the silicone membranes are sandwiched between electrodes. The relatively soft silicone then deforms according to the applied voltage.

The silicone membranes produced in the study were several micrometres thick and required high voltages to reach the desired strain. These new nanometer-thin silicone membranes with ultra-thin gold electrodes allow operation through conventional batteries. To develop a viable product, the costs would have to be reduced drastically. However, Dr. Tino Töpper, first author of the study, is optimistic: "The perfect experimental control during the fabrication process of the nanometer-thin sandwich structures is a sound basis for long-term stability—a key prerequisite for medical applications."

More information: Tino Tupper et al, Time-Resolved Plasmonics used to On-Line Monitor Metal/Elastomer Deposition for Low-Voltage Dielectric Elastomer Transducers, *Advanced Electronic Materials* (2017). DOI: 10.1002/aelm.201700073

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