Highly stretchable electronic devices using non-standard geometries

Giuseppe Cantarella[1], Alberto Ferrero[1], Luisa Petti[1], Christian Vogt[1], Niko Münzenrieder[2], Giovanni A.Salvatore[1], Alwin Daus[1], Stefan Knobelspies[1], Lars Büthe[1] and Gerhard Tröster[1]

[1] Electronics Laboratory, ETH, Gloriastrasse 35, Zurich, Switzerland
[2] Sensor Technology Research Center, University of Sussex, Richmond 3A7, Brighton, United Kingdom

giuseppe.cantarella@ife.ee.ethz.ch

Abstract

In recent years, the demand for electronics with new functionality, such as low weight, flexibility and biocompatibility is constantly growing. Smart textiles [1], bio-integrated systems [2] and electronics-on-skin are few of the countless applications that flexible electronics is enabling.
To date, a broad variety of technologies (e.g. organic materials, oxide semiconductors [3],..) and geometries (e.g. "wavy" layouts [4]) have been employed to realize electronic devices resistant to bending radii of a few tens of micrometers. The long way towards the fabrication of devices which can successfully sustain bending, but also stretching, passes from a deep analysis of the flexible substrate utilized, combined with the use of non-standard geometries, which minimize the strain experienced by the device.
Here, the realization of flexible electronic devices on a pillar-based elastomeric substrate is presented. After Finite Element Analysis (FEA) of the material properties and geometrical features (pillar height/width and pilllar-to-pillar distance) of the substrate (see Fig.1a), different materials have been evaluated to show which one better resist to mechanical strain. Based on an optimized geometry and device stack, a broad set of devices has been electrically characterized while isotropic stretching (x- and y-direction) is applied (see Fig.1b).
Thanks to the biocompatibility of the substrate material and the high mechanical strain which can be experienced by the device, this new approach can pave the way for a new class of smart electronics for on-skin applications as well as for functional medical implants.

References

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Figures

a) b)

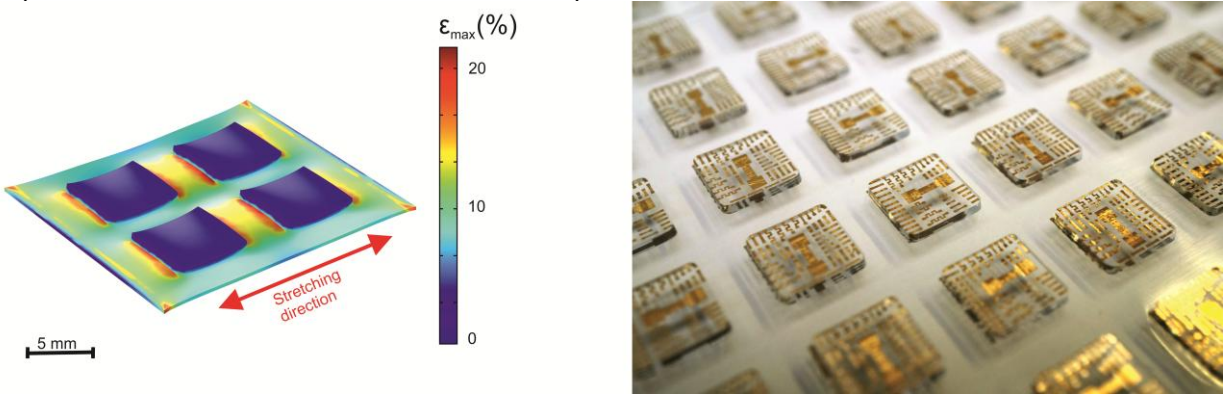

Figure 1. (A) Finite Element Analysis (FEA) of the pillar-based geometry using Polydimethilsiloxane (PDMS) as flexible substrate showing areas of high and low strain in the stretched substrate; (B) photograph of resistors (Titanium/Gold) deposited on pillars.