# Flexible thin-film transistor backplanes

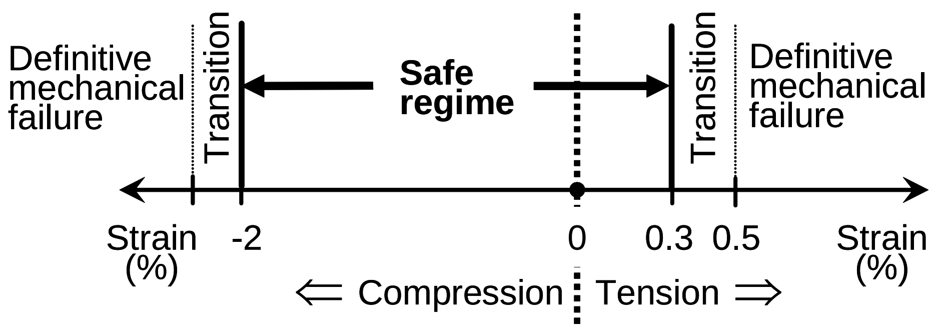
***Sigurd Wagner*, Alex Kattamis, Ke Long, I-Chun Cheng, and James C. Sturm***

Department of Electrical Engineering, and Princeton Institute for the Science and Technology of Materials (PRISM), Princeton University, Princeton, New Jersey 08544, USA

*wagner@princeton.edu

## Abstract

Flexible, lightweight, shock-resistant backplanes are of great commercial interest for displays and for sensor arrays. “Flexible” comprises bendable, conformally shaped, and elastically stretchable. We will focus on bendable transistor backplanes. While initial research concentrated on the bending of thin-film transistors, attention now has turned to the fabrication of bendable backplanes. The majority of quantitative work has been done with amorphous silicon transistors (a-Si TFTs). When these are deformed elastically, the only noticeable, and reversible, change is a rise of the TFT ON current under tension and its reduction under compression. Exceeding the elastic regime makes the TFTs fail by brittle fracture. The graph shows that the critical strain is low under tension and noticeably higher under compression. The critical tensile strain of ~ 0.3% sets an upper limit for any deformation of a-Si:H structures during fabrication and in application.




Bendable TFT backplanes should perform as well as backplanes made on glass. This goal enters in the choice of the bendable substrate, which may be an organic polymer (plastic) or a metal foil, and of the TFT process temperature. The substrate may need planarization and electrical insulation, the process temperature is lowered for plastic, and processes and chemicals are changed if they are found to attack the substrate. Because free-standing substrates must not exceed the critical strains of substrate or device films during the entire fabrication, substrate materials with low coefficients of thermal expansion must be coupled with design of specific mechanical stress into the device film stack.

We will illustrate these points with two examples. One is work toward TFT backplanes on clear plastic substrates that can be processed at glass-like temperatures. The other is the fabrication of pixel circuits on stainless steel foil for use in AMOLED displays.