Tomographic Touchpad:
Materials Characterization Behind a New Kind of Artificial Skin Sensor

Matthew A. Grayson

Electrical & Computer Engineering, Northwestern University
m-grayson@northwestern.edu,
https://www.mccormick.northwestern.edu/research-faculty/directory/profiles/grayson-matthew.html

Abstract

A tomographic touchpad is fabricated using a conducting elastomer composite. The device consists of a thin film of vinyl-methyl-silicone elastomer composite with 4-10 wt.% of multiwall carbon nanotubes (MWCNT) contacted at the periphery with 15 electrodes. The operation and testing of this device showcase three different materials characterization techniques which have broad applicability (collaboration with Noa Lachman, TAU):

1) Electrical impedance tomography – a new algorithm called "sensitivity volume electrical impedance tomography" has been developed, which allows the inversion of four-point resistance data from various combinations of contacts into a spatially varying conductivity map. Instantaneous touch-events which change the local conductivity can then be sensed and mapped.

2) Conductance monitored-stress relaxation – upon straining a composite elastomer, both the restoring force and the conductivity relax with time, so their correlation can be calibrated such that changes in local conductivity serves as a local strain sensor.

3) Capacitive contact calibration – the surface layer of composite conducting polymers is usually insulating due to self-segregation of the conductive filler. By contacting this surface layer and modeling the frequency dependence with a circuit equivalent, the true electrical thickness of the insulator is calibrated to be ~ 1 μm, larger than the apparent thickness from SEM studies.

Short Biography

Matthew Grayson is an expert in the design, fabrication, and electrical and thermoelectric characterization of electronic devices and materials. Following his initial expertise in low-dimensional electron systems such as quantum wells, one-dimensional wires, and both integer and fractional quantum Hall edges, his more recent work is on characterizing dynamic response in amorphous, glassy, polymer, and composite conductors, and characterizing thermoelectric transport in anisotropic crystals. In particular, he discovered transverse thermoelectrics, a new class of functional material for integrated thermal management. New methods in resistive tomographic imaging are being explored for 3D bioimaging as well as 2D artificial skin sensor applications. Laboratory measurement capabilities include electron transport over a continuous temperature range from 15 mK to 400 K, and high magnetic fields up to 17 T. He received a Humboldt Fellowship to conduct research in Germany at the Walter Schottky Institut of the Technische Universitaet Muenchen and an NSF CAREER Award.