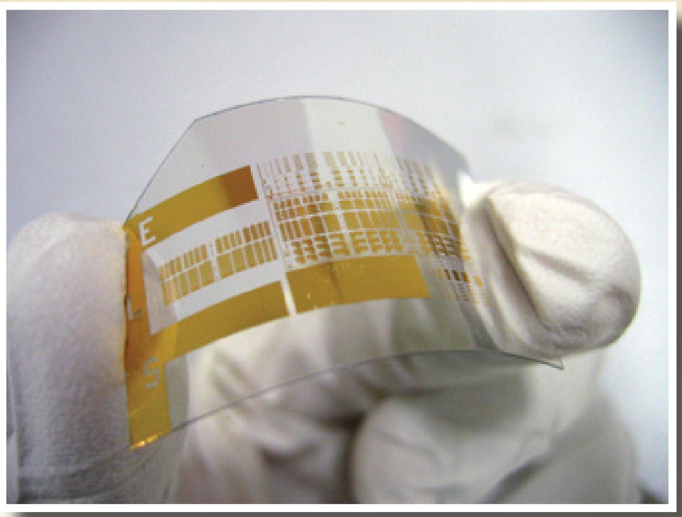
Nano-Membrane Flexible Electronics for Surveillance Radar

Accomplishment: New processing techniques for the formation, doping and transfer of silicon nano-membranes were developed and used to produce the world's fastest flexible electronic devices.

Impact: Created specifically for Air Force missions, these high speed flexible electronics enable large-area, conformal radio-frequency surveillance radar in manned and unmanned aircraft and in spacecraft. The large active area improves the radar signal, and conformal attachment reduces aerodynamic weight (by 90%), drag, complexity and cost (by 90%) associated with current protruding radar antennae. Application to conformal radio-frequency antennae is now being evaluated by a major US aerospace manufacturer for next-generation military aircraft.



Motivation and Approach: Thin electronic circuits on flexible polymer substrates offer dramatic advancements in airborne (manned or unmanned) and spaceborne surveillance radars essential to the Air Force and to national security. Their primary advantage over conventional rigid-chip systems is their thinness and flexibility, which allow conformal attachment to irregular surfaces, mounting into limited space, and resistance to damage from impact and vibration. Conformal attachment dramatically reduces the complexity, weight and drag compared to current protruding radar antennae, thus significantly improving the operational reliability of the transport aircraft. Flexible electronics are also important in missiles where space for electronics is very limited but high processing speed is needed. The electronics developed here are very robust against damage from impact and severe vibration, making them valuable for rockets and smart bombs, where significant vibration is unavoidable.

The critical component in flexible electronics is a very thin layer of silicon that is doped (alloyed with very small amounts of other elements) to give a high charge carrier mobility. Silicon is typically rigid, but is flexible when produced as 200 nanometer-thick films and bonded to a polymer substrate. However, previous processing methods were not able to perform the high temperature doping process without damaging the flexible polymer substrate. In this work, the high-temperature doping was performed while the silicon nano-membrane was supported by a silicon substrate, after which the doped silicon nano-membrane was transferred at low temperature to a flexible polymer substrate.

Team: This accomplishment was achieved by Prof. Zhenqiang Ma and Prof. Max Lagally at the University of Wisconsin-Madison. Funds were provided by the Air Force Nanotechnology Initiative Program at the Air Force Office of Scientific Research (Dr. Gernot Pomrenke, program manager) in partnership with the Air Force Research Laboratory Nanoscience and Technology Strategic Technology Team.