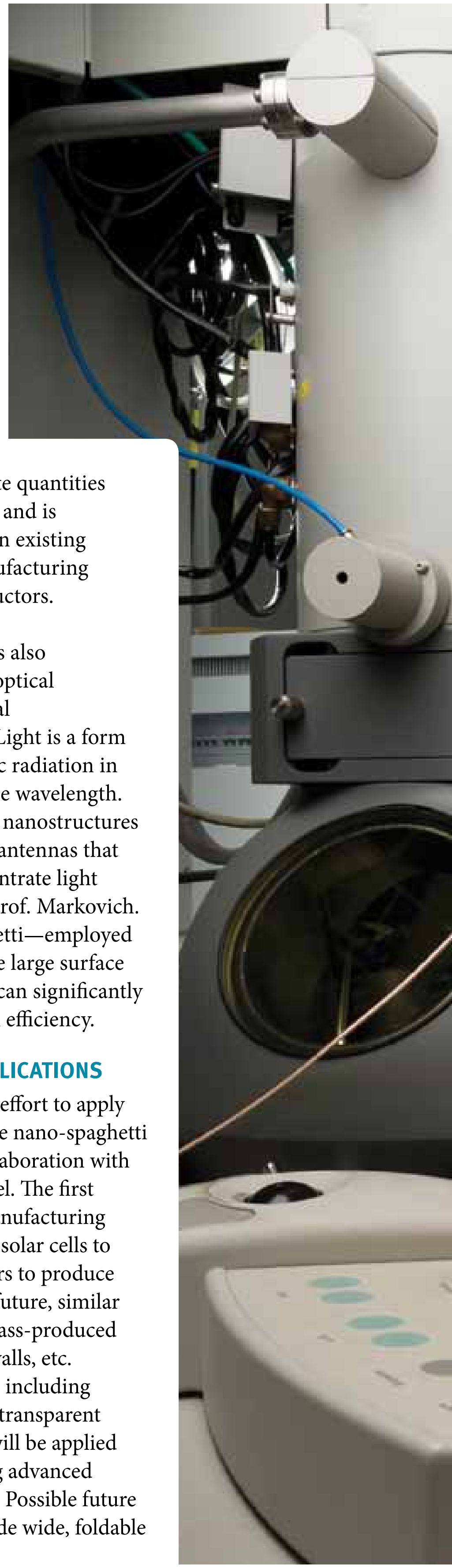
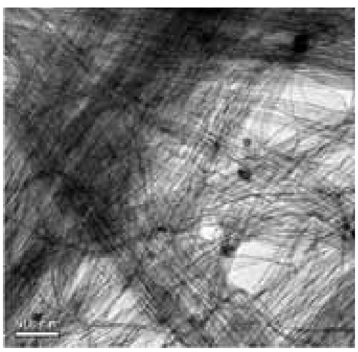
Absolute Transparency

Imagine flexible monitors that roll up for storage and unroll for use, or solar cells that fold and unfold like camping gear. These ideas may soon materialize thanks to the vision of Prof. Gil Markovich and his Raymond and Beverly Sackler School of Chemistry research team.



"Monitors today are composed of several layers, one of which is a transparent electrode—a conductive layer of a glass-like brittle material," explains Prof. Markovich, a physical chemist investigating electrical, magnetic, and optical properties of nanomaterials. "The current trend is to create electronic appliances from flexible materials such as polymers (plastic)—which will require transparent, flexible, cost-effective conductors. Research in this field is conducted worldwide and there have been a number of advanced discoveries. But we are developing a conductor that boasts several advantages over the competition, and is designed to precisely answer industry's evolving needs."



Electron-microscope image: metallic nano-fiber layer that is conductive and almost completely transparent. Fiber thickness is 2-3 nanometers—each fiber contains a mere 10-15 atoms of gold!

NANO-SPAGHETTI

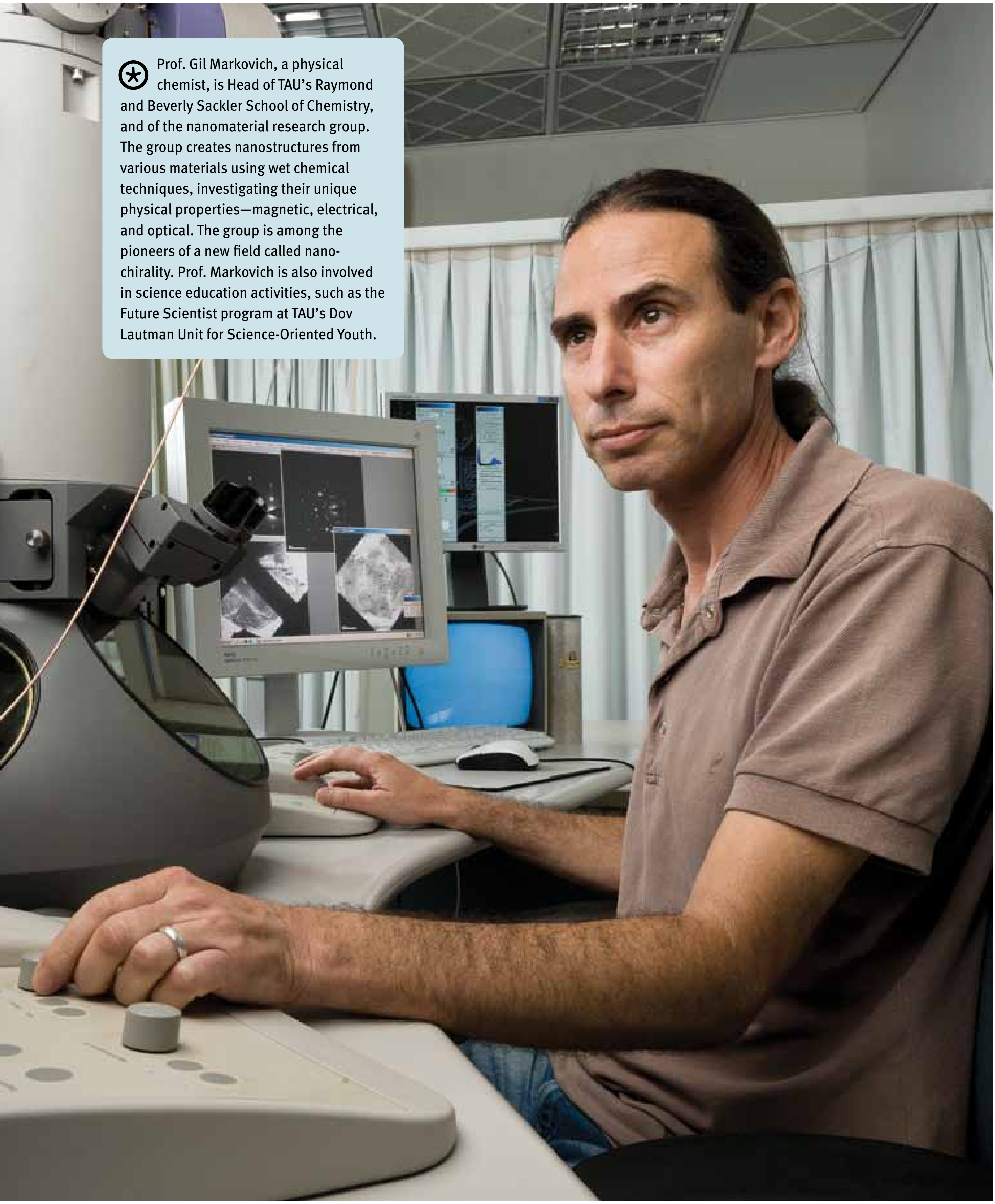
Prof. Markovich and his team's transparent electrodes are fashioned from a web of fine silver and gold nano-fibers—*nano-spaghetti*. Utilizing wet chemistry manufacturing methods, a substrate is dipped in a solution containing gold nanoparticles, which self-align and connect into fibers over the entire surface. This process, termed self-assembly, is typical of certain materials on the nanoscale. The technique's ease of use—dipping, spreading, or spraying—is its advantage.

"Other technologies, based on graphene or carbon nanotubes, call for separate manufacture of transparent flexible conductor components, after which the components are transferred onto the surface on which the electronic device is built," says Prof. Markovich. "This is a complex process with many technological hurdles. Our technique is a one-step process, with the conducting mesh self-assembling on the surface." The technology works for large surfaces, such as wide screens or solar panels. And it is cost-effective: the process occurs on the nanometric scale, using minute quantities of gold and silver, and is less expensive than existing methods for manufacturing transparent conductors.

Prof. Markovich is also investigating the optical properties of metal nanostructures. "Light is a form of electromagnetic radiation in a nanometric-scale wavelength. That is why metal nanostructures can serve as nanoantennas that receive and concentrate light waves," explains Prof. Markovich. Thus nano-spaghetti—employed as antennas on the large surface of a solar panel—can significantly improve solar-cell efficiency.

PROMISING APPLICATIONS

There is a current effort to apply and commercialize nano-spaghetti technology in collaboration with PV Nanocell, Israel. The first phase involves manufacturing sheets of polymer solar cells to be used by campers to produce electricity. In the future, similar sheets could be mass-produced to coat surfaces, walls, etc. Each of the layers, including Prof. Markovich's transparent conductor layer, will be applied to the sheets using advanced printing methods. Possible future applications include wide, foldable LCD screens.



Prof. Gil Markovich, a physical chemist, is Head of TAU's Raymond and Beverly Sackler School of Chemistry, and of the nanomaterial research group. The group creates nanostructures from various materials using wet chemical techniques, investigating their unique physical properties—magnetic, electrical, and optical. The group is among the pioneers of a new field called nano-chirality. Prof. Markovich is also involved in science education activities, such as the Future Scientist program at TAU's Dov Lautman Unit for Science-Oriented Youth.