Oxides for flexible, transparent electronics

Functional thin-film oxides are opening the door to an array of new high-power devices and smart sensors, launching a new era in electronics. EU-funded researchers produced new metal-oxide materials and provided useful modelling techniques that speed up their development.

Metal-oxide nanoparticles have electrical, magnetic and mechanical properties allowing the production of transparent devices through patterned deposition on flexible substrates at low temperatures. They are thus receiving widespread attention as an enabling technology for next-generation electronics.

To unlock their full potential, researchers adopted a holistic approach within the project ORAMA (Oxide materials towards a matured post-silicon electronics era). Modelling of material properties supported experimental research work on the synthesis of oxide materials suitable for energy-efficient lighting, display electronics and chemical sensing.

Material synthesis focused on active semiconductor oxides and passive transparent conducting oxides with binary, ternary and quaternary structures. Advanced simulations offered researchers a perfect tool for modelling electronic band structures, doping mechanisms and optical properties of these materials.

Researchers also produced a heuristic model to predict the thin-film morphology of thin oxide films deposited by plasma processes. They successfully simulated film growth using the particle-in-cell plasma technique.

Three prototypes were developed collaboratively to demonstrate how newly developed materials can be utilised in specific products. These were a steering wheel application with displays and reconfigurable icons, multifunctional glazing and gas sensors. Researchers used low-temperature, damage-free deposition and additive patterning techniques to integrate the new materials in the device concepts.

In the first prototype, researchers replaced traditional switches, knobs, sliders and buttons with touchscreen functions. The newly developed positively charged materials for monitoring low-concentration gases offer the potential for printing these sensors on flexible substrates. By replacing glass in car windows with plastic glazing in the third prototype, the team achieved a decrease in cost and weight.

The innovative metal-oxide thin-film materials produced enable the development of a new generation of transparent and flexible electronic devices. Given that they do not contain any scarce metal and are low-cost and eco-friendly, metal oxides have high potential for replacing silicon in electronic devices in the near future.