PRESS RELEASE

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ICMAB researchers confirm the mechanism that makes transparent the metals on the smartphone touchscreens

- ***A team led by Josep Fontcuberta has experimentally proven a theory they proposed in 2021***
- ***Vibrations inside the material influence how electrons move and make these metals transparent***
- ***These metals are key parts in daily life devices, such as smartphone touchscreens, photovoltaic cells, or OLED screens***

Researchers Josep Fontcuberta (L) and Gyanendra Singh (R) | ICMAB-CSIC

Bellaterra (Spain), 16 March 2026 – Researchers from the Institute of Materials Science of Barcelona (ICMAB-CSIC) Gyanendra Singh and Josep Fontcuberta have experimentally confirmed a theory they proposed in 2021 that explains the mechanism by which some metals are transparent. Their findings, published in the journal Physical Review Letters, show that electrons in these materials move more slowly because they interact strongly with the vibrations of the material, so they cannot respond to visible light in the way electrons normally do in common metals. This work has been carried out in close collaboration with the Paul Scherrer Institut and ETH Zurich (both in Switzerland).

Transparent and electrically conductive materials are essential in technologies such as touch screens and photovoltaic cells. Although metals normally reflect visible light, some metallic oxides behave differently and become unexpectedly transparent. Understanding why this happens is crucial for developing new materials that could one day replace scarce elements used in today's devices.

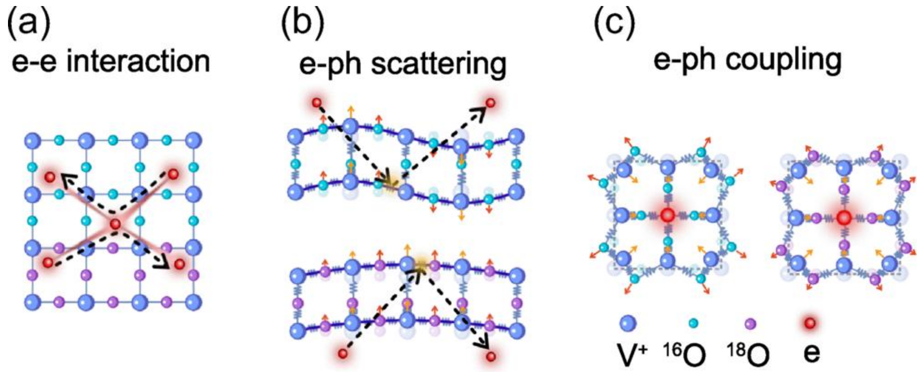
The structure of these metals slows down electrons and they cannot react to visible light

In 2021, ICMAB researchers led by Josep Fontcuberta studied thin films of strontium vanadate and concluded that their transparency could not be explained by strong electron-

electron interactions, which had been the accepted view until then. It had to be something else.

In many oxide materials, the atoms are arranged in a very orderly, three-dimensional grid. Some of these atoms are positively charged and some are negatively charged. Together, they form a stable, repeating structure, similar to the scaffolding of a building. This structure called the ionic lattice. Electrons move through the spaces in this structure. When they interact with the atoms in the lattice, the atoms can shift slightly from their positions, creating small vibrations

The team found evidence that the electrons move together with these small vibrations of the lattice, thus slowing the atoms down. Because they that, they cannot react to visible light in the way they would in an ordinary metal. Therefore, the light is not reflected and can pass through the material.



Sketches of: (a) scattering, (b) -ph scattering, and (c) polaron formation in and -SVO, as indicated. | Authors of the study

Confirming the mechanism five years later

To test their hypothesis, the researchers carried out a set of experiments that required changing the mass of the atoms in the material without altering the number of electrons. They achieved this by replacing part of the oxygen-16 atoms in the strontium vanadate films with the heavier oxygen-18 isotope. This substitution modifies the way the atoms vibrate while keeping the overall electronic density unchanged.

The behaviour of the electrons changed exactly as predicted: when the atoms became heavier and their vibrations slowed down, the electrons also changed their dynamics. This provided direct and convincing evidence that the interaction between electrons and lattice vibrations is what governs the transparency of these metallic oxides.

Josep Fontcuberta, leader of the ICMAB group behind the study, emphasises the significance of this result:

> "This last step (the isotopic substitution instrumental on falsifying our hypothesis) has required extensive and dedicated work. If phonons are responsible for dressing the carriers, then if the mass of ions in the lattice is changed the corresponding atomic vibrations should be modified and therefore the coupling the itinerant carriers

> (electrons) altered. To do so we have undertaken a long path that, in collaboration with our partners from PSI-Villingen (Switzerland), involves a partial substitution of 16O in SrVO3 thin films by its heavier isotope 18O, while keeping to total electron density constant."

These findings challenge the long-standing view that electron-electron interactions are the main reason why electrons in metallic oxides behave as if they were heavy. Instead, they demonstrate that electron-phonon coupling plays the dominant role. This new perspective changes how researchers understand the optical properties of these materials and must be taken into account when developing future transparent conductors.

Transparent and conductive materials in everyday devices

Touchscreens in our smartphones are made with a transparent material, it looks like glass, though it is not. Glass is not conductive, and these screens need to be both transparent and electrically conductive. The same type of materials is also used in photovoltaic cells, LEDs, or OLED screens.

These components are essential for technologies that have become part of our daily lives, yet many of the materials currently used depend on scarce chemical elements. Touchscreens, in fact, are one of the most expensive parts of a modern smartphone due to this situation and their high demand. Understanding why certain metallic oxides can be transparent is a key factor for developing alternative materials that can reduce the dependence on these rare resources.