High Quality Transparent Conductive Oxide Thin Films

Technology No. 20170385

Comparable Conductivity to ITO

A growth approach for synthesizing lanthanum (La) doped barium tin oxide (BSO) shows high room-temperature conductivity and mobility. The synthesis method, called radical-based hybrid chemical beam approach, uses a chemical precursor for tin as a substitute for the solid tin source in a hybrid molecular beam epitaxy approach. The method produces highly transparent, highly reproducible and commercially scalable transparent conductive oxide (TCO) thin films. The room temperature conductivity of these transparent and conductive films is comparable to the best reported values in indium-doped tin oxide (ITO), the industry standard TCO.

Dr. Bharat Jalan and his research team, have been recognized as a 2018 TechConnect Innovation Awardee for their technology, “Transparent Conducting Oxide Film – Indium Tin Oxide Alternative."

Highly Transparent, Highly Reproducible, Commercially Scalable

Previous attempts at using La-doped BSO (La:BSO) for replacing ITO have faced several challenges that this new method overcomes:

- Higher reproducibility. Conventional molecular beam epitaxy growth methods provide inconsistent electronic properties for the same growth conditions. In addition, the methods that are reproducible (such as high-oxygen pressure sputtering) suffer from inferior electronic properties. This new approach is both highly reproducible and commercially scalable.
- Increased Tin (Sn) reactivity. Elemental Sn has a low oxidation potential, and while the low Sn reactivity can be solved by using SnO2 instead of solid Sn as the source, it is not reproducible and produces films with poor surface morphology and electronic transport properties. By using hexamethylditin instead as the tin source, the new method increases

Sn reactivity and produces tin radicals with a +4 oxidation state.
- Indium replacement. Transparent electronics currently use ITO, but indium is becoming less abundant every year and is projected to run out in the next few decades. To mitigate the expense and eventual shortage of indium, barium stannate has been introduced. However, while showing promising room-temperature electronic properties, BSO conductivity is much lower than ITO. The synthesis approach in this technology achieves better properties, making La:BSO a viable alternative to ITO.

BENEFITS AND FEATURES:

- Viable ITO alternative
- Very stable at high temperatures (~800 °C in air, ~600 °C in vacuum)
- Superior conductivity >10^4 S cm^{-1} (comparable to best-reported ITO values)
- High room-temperature mobility (Up to 120 cm^2 V^{-1} s^{-1})
- Excellent sheet resistance (2-5 ohms per square for 120 nm thick film)
- High reproducibility
- Highly scalable process
- Highly transparent/low haze films
- Improved structural quality

APPLICATIONS:

- ITO replacement (i.e., for touch screens, liquid crystal displays, conductive window heaters, head-up displays, plasma displays, aircraft windshields, organic LEDs, solar panels)
- Transparent conductive films
- Semiconductors
- Electronics

Phase of Development

Proof of concept. Future work will focus on making these transparent, conductive films using commercially available deposition processes.

Researchers

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Publications

Wide bandgap BaSnO3 films with room temperature conductivity exceeding 104 S cm−1
Nature Communications, 8, Article number: 15167 (2017)

Files and Attachments

Award [JPG]
Non-confidential Summary [PDF]

Interested in Licensing?

The University relies on industry partners to scale up technologies to large enough production capacity for commercial purposes. The license is available for this technology and would be for the sale, manufacture or use of products claimed by the issued patents. Please contact us to share your business needs and technical interest in this thin film technology and if you are interested in licensing the technology for further research and development.