Materials & Chemicals

Perovskites as Ultralow Work Function Cathode Materials

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WARF: P160033US02

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing perovskite materials newly identified for use in high power vacuum electronics, microwave technologies and thermionic energy conversion.

Overview

Electron emission cathode materials are found in high power electron beam devices used in defense, scientific research and communications applications as well as thermionic energy conversion technologies. Suitable electron source materials desirably exhibit a low work function, stability at high temperatures, and sufficient conductivity to sustain the desired emission current.

Leading thermionic electronic emitters composed of refractory metals like tungsten – while stable and good conductors – must be coated with an oxide to lower the work function. These coatings are volatile and degrade over time, limiting the lifetime and efficiency of devices.

Alternatively, perovskite materials are of interest because they possess desirably low work functions and may eliminate the need for a volatile surface layer. Determining the work function values for perovskites is essential for applications involving electron transport at interfaces or surfaces, including solar cells, electrocatalysts, conducting oxide electronics, Schottky barriers and vacuum electron emitters as well as thermionic energy conversion.

The Invention

Using high-throughput computing and informatics to screen thousands of candidates, UW–Madison researchers have identified a perovskite oxide, $SrVO_3$, with a lower predicted work function than current state-of-the-art cathodes.

$SrVO_3$ exhibited one of the lowest calculated work functions (1.86 eV) out of 18 perovskite materials investigated (~ 40 compositionally distinct surfaces). Non-volatile barium doping was used to further lower the work function (1.07 eV) and was more stable than on tungsten or scandium surfaces, indicating that Ba will reside on $SrVO_3$ orders of magnitude longer than on other widely explored thermionic cathode material surfaces.

Applications

- $SrVO_3$ (with or without Ba doping) for ultralong lifetime, highly emissive cathode material
  - Thermionic emission technologies
  - High power vacuum electronic devices
  - High power microwave components and systems

Key Benefits

- Lower work function and more stable barium adsorption than existing technologies (e.g., tungsten or scandate surfaces)

- Potential for significantly extended cathode lifetime and higher electron emission levels

Stage of Development

Work function calculations were performed using density functional theory (DFT) with hybrid functionals (HSE).

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

For More Information About the Inventors

- Dane Morgan
- John Booske

Related Technologies

- For information about perovskite-based cathodes for solid oxide fuel cells and related technologies, see WARF reference number P160222US01.

Publications

- Read a news story about this technology.

Tech Fields

- Materials & Chemicals : Composites

For current licensing status, please contact Mark Staudt at mstaudt@warf.org or 608-960-9845