

GENDER DIVERSITY | More than half of the research team comprises women **POWER IN COLOUR: IIT-Indore's supercapacitor redefines energy storage**

Our Staff Reporter

INDORE

Researchers at Indian Institute of Technology Indore have developed a path-breaking technology that could change the future of energy storage. The team, led by Prof Rajesh Kumar from Materials and Device (MAD) Lab of the Physics Department, has created a revolutionary color-modulating supercapacitor that not only stores energy but also shows its charging status through visible color changes, while blocking infrared heat.

This electrochromic supercapacitor visually indicates its charge level — red when fully charged, green when half charged, and blue when fully discharged. This simple, real-time colour feedback removes the need for separate monitoring circuits and allows users to know the device's energy status instantly. The colour change is made possible through the electrochromic properties of a specially designed vanadium oxide complex that changes its optical

characteristics during charging and discharging.

What makes this technology unique is its dual functionality. In addition to storing energy, the device actively blocks infrared heat by adjusting its heat-blocking ability with small electric currents. The prototype has shown excellent performance, achieving optical modulation of up to 70% at red colour and 50% at blue colour. The research team has used a specially tuned oxide-hydroxide complex of porous vanadium oxide that maximises electroactive sites and ensures high efficiency.

The device is solid-state and flexible, meaning it can be bent or twisted without affecting its performance. The researchers have successfully demonstrated the technology using a large 25 cm² prototype, proving that it can be scaled up for real-world applications. Prof. Rajesh Kumar highlighted that this technology will be of immense use for industry working for the electrification of gadgets and vehicles. With small design



changes, the same platform can also be used to create electrochromic batteries.

An important aspect of this achievement is the significant contribution of women scientists to the project highlighting the importance of gender diversity in advancing scientific innovation. More than half of the research team comprises women, including Bhumika Sahu, Dr. Tanushree Ghosh, Nikita and Dr. Suchita Kandpal, along with lead researcher Dr. Love Bansal and Deb Kumar Rath. One of the lead researchers Dr. Love Bansal is a Translational Research Fellow (TRF) under the pioneering Translational Research Fellowship scheme of IIT In-

dore which provided financial support during the research.

Rajesh Kumar said, "Our technology combines energy storage, heat control, and visual feedback in one compact device, offering users a smarter, more efficient way to manage energy. It has the potential to transform multiple sectors, from consumer electronics to electric vehicles."

This innovation from IIT Indore is poised to become a game-changer for green energy solutions. As it moves towards commercialisation, it promises to make energy storage more efficient, intuitive and sustainable, supporting the global transition to renewable energy.

Immense potential in automotive, bldg industry

This innovation has immense potential for industries such as automotive, where electrochromic applications are growing rapidly. The global automotive supercapacitors market, valued at USD 1.3 billion approx., in 2023, is expected to rise to USD 7.5 billion approx. by 2032, showing a 22% annual growth rate. The technology can also help in smart buildings by filtering heat and reducing cooling costs while remaining transparent. In electric vehicles, it can improve energy efficiency through better thermal management and energy storage.



This breakthrough is a proud moment for IIT Indore. It reflects our commitment to developing technologies that not only meet India's energy needs but also contribute to global sustainability goals. The TRF scheme has played a key role in nurturing such innovations by providing dedicated support to young researchers working to bridge the gap between laboratory research and industrial application.

Prof Suhas Joshi,
Director, IIT Indore