Patent application for innovative film - possible Indium Tin Oxide replacement

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Jude Iroh's research has led to a provisional patent application for an innovative film with remarkable properties. Credit: University of Cincinnati

Jude Iroh, professor of materials science and engineering at the University of Cincinnati holds several patents dating to his days as a graduate student. Another may soon be on the way.

On Nov. 5, Iroh filed a provisional patent application with the U.S. Patent Office for a polymer-based film with remarkable properties. The film is highly transparent and electrically conductive. It has potential uses in energy, including applications in solar and fuel cell technology. It is economical, easily processed, durable, flexible, and heat resistant.

"Because of its properties, this film is very flexible," Iroh said. "I can envision a very thin solar panel that can be unrolled and applied, perhaps

to an automobile, while the sun is shining, then peeled off and stored."

More importantly, Iroh's innovative film has the potential to replace a substance known as ITO, an abbreviation for Indium Tin Oxide. While the acronym may be unfamiliar to most consumers, ITO's uses are not. ITO is behind most touch-screen devices like smart phones and video kiosks. It appears in flat panel displays, electronic inks, and organic light-emitting diodes (LEDs).

ITO is also expensive and rare. It is fragile, lacks flexibility, and it is requires complicated processes to apply. All the major sources of Indium lie outside the United States, lending a strategic value to a suitable replacement for ITO.

Development of the new film grew out of Iroh's work on coatings.

"My initial focus was in composites, particularly laminated composites," he said. "It was for that work that I received my first patents."

After earning his Ph.D. from the University of Connecticut in 1990 and a Post-doctoral stint at Temple University, Iroh accepted a position at the University of Cincinnati as an assistant professor on September 1, 1991. His research attracted the attention of the Office of Naval Research, which asked him to look into coatings to protect metal. Iroh's projects earned acclaim from the Office of Naval Research, and he was named an ONR Young Investigator for 1995-1999. This honor was followed by others. Iroh was selected as the Sigma Xi Young Investigator at the University of Cincinnati for 2001, and was named a Resident Senior Research Associate at the Air Force Research Laboratory for 2002-2003. In 2004 he was elected as a Fellow of the Society for the Advancement of Materials and Process Engineering, SAMPE.

For the naval work, Iroh adapted a laminating process to apply coatings

to steel.

"I was using what was then a new class of polymer, intrinsically conducting polymer, and applying it for corrosion prevention measures," he said.

Over the years, Iroh has tackled substantial problems related to coating materials. For example, adding trace amounts of various substances can improve corrosion prevention, but these "dopants" can be lost due to weather, defeating the purpose of the coating. Other coatings are very effective, but must be cured at high temperatures.

"We have found methods to reduce curing temperatures by more than 100 degrees Celsius," Iroh said. "That is very significant."

Effective coatings must meet a wide range of requirements, Iroh said. Cost is a factor, as is ease of application, environmental safety, ability to adhere and impact resistance.

The impact resistance of nanocomposite coatings has opened a fruitful partnership between Iroh's laboratory and Jackson State University, a historically black university in Mississippi. Funded by the Office of Naval Research, Jackson State students are working with Iroh's lab on low temperature systems for high-impact epoxy coatings.

"I would hope to see some of these students return here one day as graduate student," he said.

As Iroh gained more insight into the function of various substances as coatings, it occurred to him that these coating had useful properties, even if they were not coating something.

"A coating is essentially a film. What properties does this film possess?"

Iroh said.

It was the question that led to the development of the highly transparent, electrically conductive, polymer-based nanocomposite film.

"This breakthrough will give us a unique place in the broader field of composites and energy research," he said. "This is an exciting development, and I am glad that my research group is very well positioned to continue to make a significant impact in this area."

Provided by University of Cincinnati