

Scientists develop cheaper catalysts to cut fuel-cell cost

The team shows zirconium-based substance can replace expensive platinum in fuel cells

TV JAYAN

New Delhi, November 19

The quest for developing cheaper but better fuel cells has just got a boost. A research team, that includes a scientist from Indian Institute of Technology (IIT) Madras, may have found a cost-effective substitute to platinum catalyst, which is essential for fuel cells to function, but accounts for almost a-fifth of their cost.

In a paper published on Monday in the journal *Nature Materials*, a team of materials scientists from India, China and the UK claimed that catalysts made of zirconium nitride nanoparticles that they developed could be a superior alternative to platinum catalysts for use in fuel cells and metal-air batteries.

Apart from Tiju Thomas of IIT-Madras, Minghui Yang of Ningbo Institute of Materials Technology in Ningbo in China and John Paul Attfield of the University of Edinburgh are the main authors of the study, which showed that zirconium nitride nanoparticles can be a highly attractive alternative to platinum. "Platinum is the gold standard as far as fuel cell catalysis is concerned," said Thomas, an associate professor at the Department of Metallurgical and Materials Engineering at IIT-Madras.

If what they discovered in the lab can be translated into real applications, there could be more cost-effective and efficient fuel cells in the market in near future. After all, platinum is a scarcely available metal on earth and costs

around ₹2,750 per gm. Zirconium, on the other hand, is abundantly available and is at least 700 times cheaper than platinum. Platinum catalysts are said to account for nearly 20 per cent of the cost of a fuel cell.

"We are willing to work with industry to develop innovative products based on our findings," Thomas told *BusinessLine*.

What is a fuel cell?

Fuel cell is a device that converts chemical energy stored in molecular bonds of chemicals into electrical energy. In more commonly-used hydrogen fuel cells, platinum catalyst is used for splitting hydrogen atoms into positively-charged hydrogen ions and electrons. While electrons flow out to produce direct current electricity, positive hydrogen ions combine with oxygen supplied through another elec-



A representative image of a fuel cell

trode to produce water, paving the way for the production of the one of the cleanest forms of energy.

"In not so distant future, we are to witness a radical reorganisation of the energy landscape – from one that is based on carbon to that relies on renewables," said Thomas.

Fuel cells and metal-air batteries play an instrumental role in this transition and they may even become

more common-place in one-to-three decades, he said. They may find increasing applications in automotive industry and in off-grid power generation among others. One of the major limiting factors that prevent them from being widespread is the prohibitive cost of platinum.

Low-cost materials that have a high catalytic activity and durability have remained elusive, so industrial use is largely limited to platinum-based catalysts for fuel cells, for example, in automotive applications, the scientists said.

The research team stumbled upon zirconium nitride almost serendipitously. About a decade and a half ago, while working in a Cornell University lab, Thomas and Yang realised the promise that nitrides can offer as catalysts and continued to work on them even after they moved back to

their respective countries. Thomas, who has been on a visiting position offered by Chinese Academy of Sciences for last 9 years, has been working closely with Yang's team. In 2018, for the first time, they quite accidentally discovered that zirconium catalysts can actually surpass that of platinum, said Thomas whose lab works on nitride and oxynitride catalysts.

In the present study, the scientists found that zirconium nitride catalysts can not only perform all functions of platinum-based ones, but also surpass many of them. Zirconium nitride catalysts, for instance, have better stability than their platinum counterparts. Platinum catalysts used in fuel cells are seen to degrade over a period of time. Zirconium nitride catalysts, on the other hand, were found to decay at a much slower rate.