Towards sustainable fuel cells

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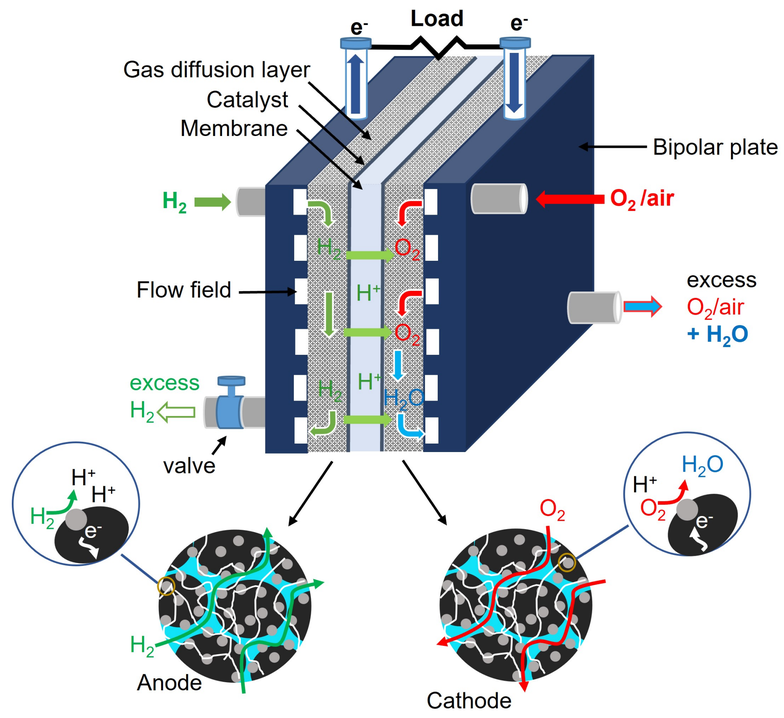
Hydrogen and fuel cell

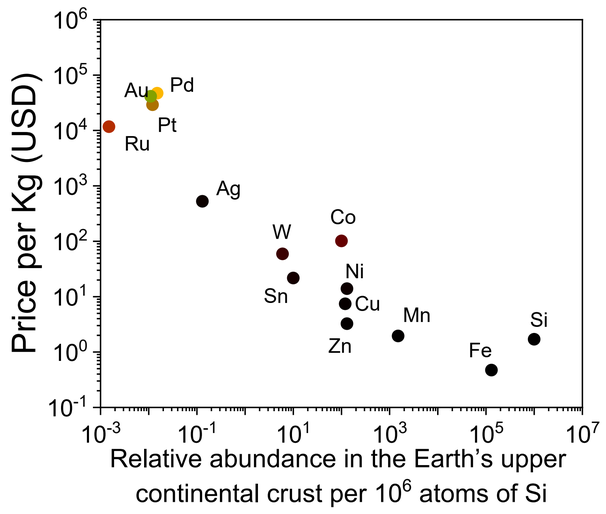
Hydrogen is considered as a universal energy carrier due to its potential to store renewable energy with high density from water electrolysis.

The stored hydrogen can then be converted to electricity by a fuel cell and the process can be continuous as long as hydrogen is supplied.



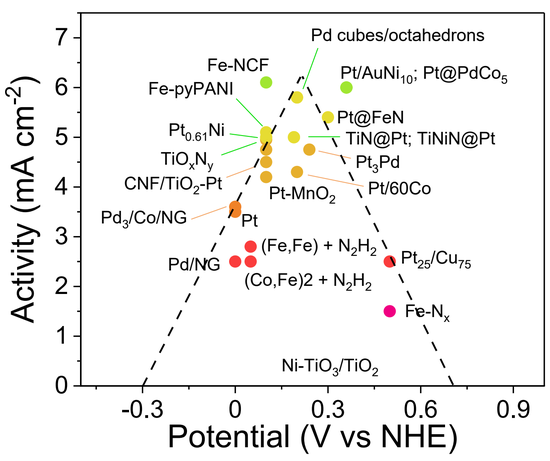
Key challenges with the current technologies:

An excessive dependence on platinum (Pt) catalyst, inflexibility in the cell manufacturing, heaviness and bulkiness of polymer electrolyte membrane fuel cell (PEMFC) stack due to graphite bipolar plates, and reliance on secondary devices such as oxygen/air cylinders and air compressors.



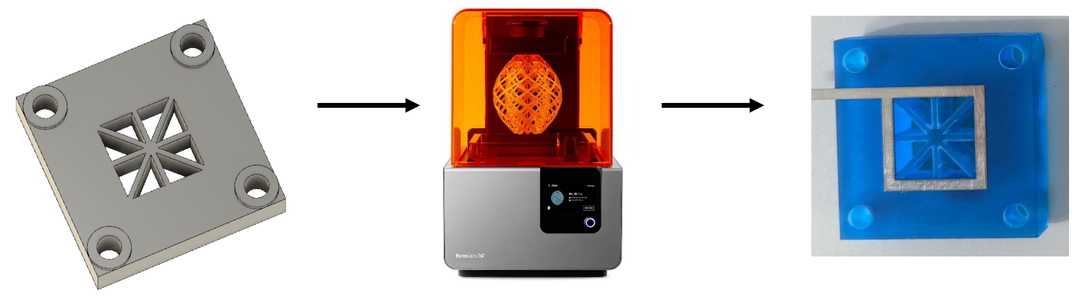
Developing sustainable PEMFC

- Reduce Pt amount and enhance activity by alloying Pt with other metals
- Remove ancillary devices by enabling self-breathing
- Replace graphite with stainless steel and plastic
- Simplify manufacturing with 3D printing



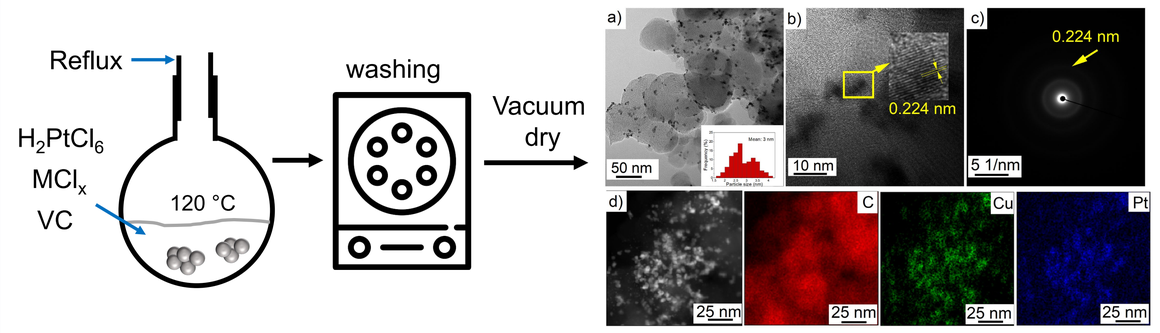
3D printed self-breathing PEMFC

Novel approach to cell/stack manufacturing can lower the manufacturing cost and achieve an economies of scale.

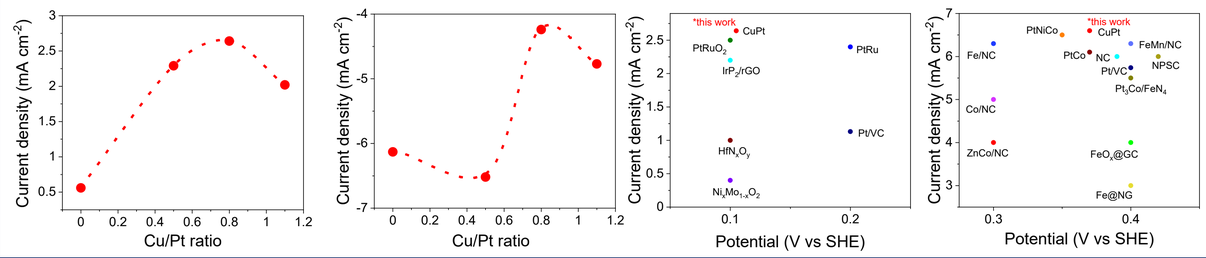


Highly active Pt alloy catalyst

Polyol process, metal salt precursors, ethylene glycol as a reducing agent, water as a solvent and vulcan carbon (VC) as a catalyst support.

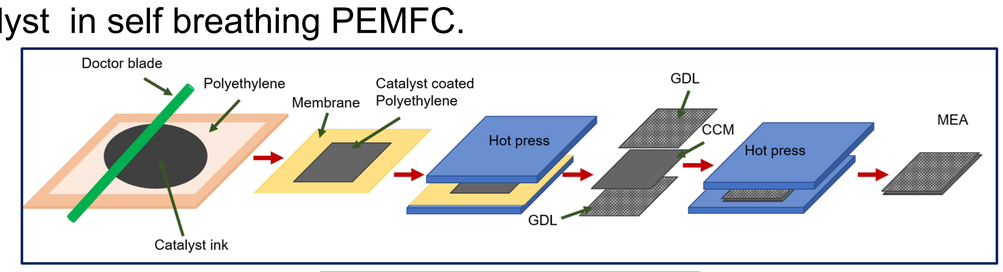


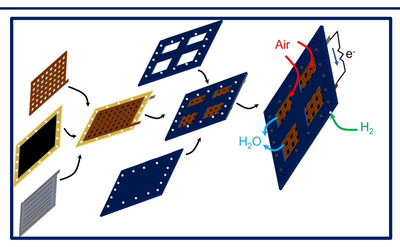
Highly dispersed Pt alloy on VC, superior catalytic activity for hydrogen oxidation and oxygen reduction against current state of art catalysts.

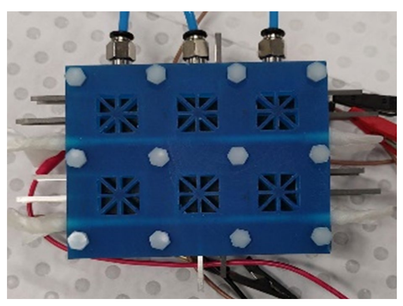


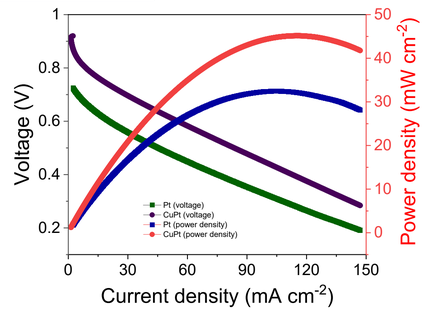
Fuel cell performance

Pt alloy delivered 50% more power with 60% less Pt compared to Pt only catalyst in self breathing PEMFC.









Massive reduction in cost, weight can be achieved with Pt alloy catalyst under self-breathing PEMFC operation.

References

Prabal Sapkota, Cyrille Boyer, Rukmi Dutta, Claudio Cazorla and Kondo-Francois Aguey-Zinsou, ***Sustainable Energy Fuels***, 2020,**4**, 439-468

Prabal Sapkota, Cyrille Boyer, Sean Lim, Kondo-Francois Aguey-Zinsou, ***ACS Applied Energy Materials*** *(submitted)*