# Metal Atoms on Surfaces & Interfaces (*MASI*) for Sustainable Future

## What is MASI?

This is a large-scale multidisciplinary project spearheaded by four UK universities (Nottingham, Cardiff, Cambridge, Birmingham) and involving a number of industrial partners, which is set to revolutionise the ways we use metals in a broad range of technologies. At the core of MASI is a unique method for breaking bulk metals down to single metal atoms (SMA) or nanoclusters (MNC) of precise size and chemical composition. The aim of the MASI project is two-fold: *(i)* to provide a solution for a *sustainable use of scarce metals of technological importance* (*e.g.* Pt, Au, Pd), by maximising utilisation of every atom, and *(ii)* to unlock *new properties that emerge in metals only at the atomic scale*, leading to substituting critical metals with abundant ones (*e.g.* Pt with Ni), and providing a platform for next generation of materials for energy, catalysis and electronics.

## How does it work?

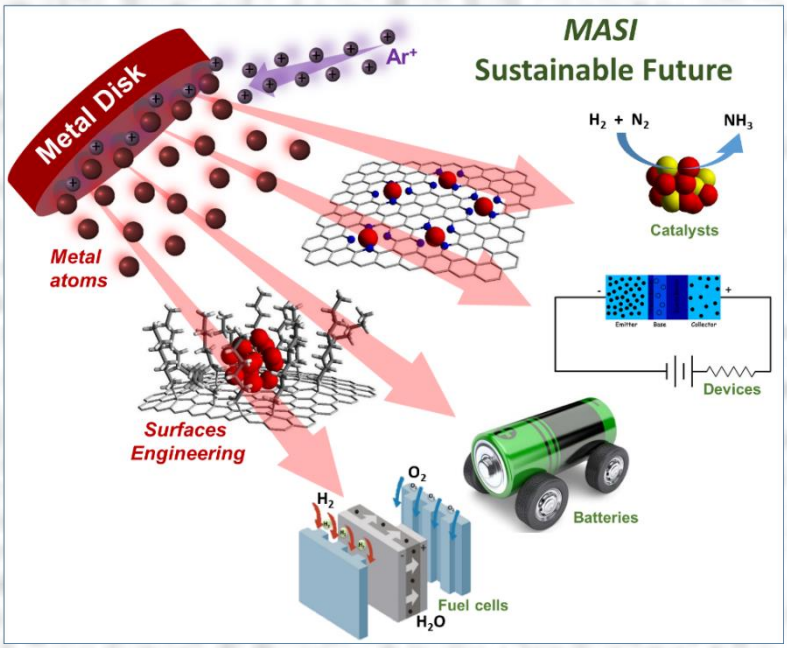
- In our magnetron sputtering system ions of argon strike the surface of a metal plate and sputter metal atoms or nanoclusters with their size precisely controlled. Up to five different metals can be mixed within the nanoclusters.
- We apply high-level theoretical modelling to predict and control metal atom / nanocluster formation and deposition, and to design innovative support materials to harness full potential of metals.
- Metal atoms or nanoclusters are deposited directly onto solid (*e.g.* glass, polymer film, paper etc.), powder (e.g. silica, alumina, carbon etc.) or non-volatile liquid (e.g. oils, ionic liquids) in vacuum with no chemicals, solvents or surfactants, with the metal loading accurately controlled.
- Surfaces of our metal nanoclusters are ‘naked’, clean and highly active, and are stabilised by interactions with the support material, ready to be applied wherever metals are required.
- We investigate atomic scale dynamics of metals in chemical and electrochemical reactions by advanced analytical and materials characterisation methods.
- We test catalytic, electrochemical and electronic properties of these materials to identify top candidates for key practical applications.

## What is unique about these materials and our technology?

- Greener, more sustainable method of fabrication of SMA/MNC without solvents or chemicals.
- Maximised active surface area ensuring efficient use of each metal atom.
- ‘Naked’, highly active metal surface, activated by heat, light or electric potential for reactions with molecules.
- Tuneable interactions with support material providing durability and reusability.
- High capacity for energy storage/conversion required in batteries and fuel cells technologies.
- Fully scalable SMA/MNC fabrication technology.

## Why us?

In 2018, the University of Nottingham launched a magnetron sputtering facility, unique in the UK and in Europe (analogues exist only in Japan, Brazil and USA). Within MASI project, in cooperation with University of Birmingham possessing a long-standing expertise on metal cluster fabrication by physical vapour deposition and fuel cells technology, University of Cardiff - the leading centre of catalysis in the UK, University of Cambridge renowned for pioneering use of nanomaterials in electronic devices and batteries, we form a powerful group of scientists and engineers ready to make significant impact on industry, economy and society in the UK and globally.




5 nm