particle may be varied to optimise catalytic activity and stability of the particle.

Advantageously, the particle exhibiting catalytic activity may be used to catalyse an ORR or a carbon-nitrogen coupling reaction.

It has been found in an embodiment where the particle comprises a platinum outer shell and an AuCu core, the particle exhibits superior electrocatalytic activity and excellent stability towards ORR. The gold component in the AuCu alloy core may be crucial towards stabilising the platinum outer shell during ORR. The high electrocatalytic activity of the particle may be due to the compressive strain effect exerted by the AuCu alloy core on the platinum outer shell, which is induced by the slightly smaller lattice parameter of the AuCu core as compared to that of the platinum outer shell. In addition, the use of an AuCu core may substantially reduce the platinum loading in the resulting particle, hence leading to costs savings.

According to ~~a second aspect~~the present disclosure, there is provided a method of forming a particle exhibiting catalytic activity comprising the steps of i) forming an inner core of the particle exhibiting catalytic activity, the inner core comprising an alloy material, and ii) forming an outer shell of the particle exhibiting catalytic activity on the inner core, the outer shell comprising a metal material.

According to a second aspect, there is provided a method of forming a particle exhibiting catalytic activity comprising the steps of i) forming an inner core of the particle exhibiting catalytic activity, the inner core comprising an alloy material, and ii) forming an outer shell of the particle exhibiting catalytic activity on the inner core, the outer shell comprising a metal material,

wherein the alloy material is selected such that the inner core exerts a compressive strain on the outer shell.

According to a third aspect, there is provided a catalyst comprising a plurality of particles exhibiting catalytic activity, each particle comprising (a) an inner core formed of an alloy material; and (b) an outer shell formed of a metal material surrounding the inner core; wherein the alloy material is selected such that the inner core exerts a compressive strain on the outer shell.

According to a fourth aspect, there is provided an oxygen reduction reaction catalyst comprising a plurality of particles exhibiting catalytic activity, each particle comprising (a) an inner core formed of an alloy material; and (b) an outer shell formed of a metal material surrounding the inner core; wherein the alloy material is selected such that the inner core exerts a compressive strain on the outer shell.

According to ~~a fifth aspect~~the present disclosure, there is provided a carbon-nitrogen coupling reaction catalyst comprising a plurality of particles exhibiting catalytic activity, each particle comprising (a) an inner core formed of an alloy material; and (b) an outer shell formed of a metal material surrounding the inner core; wherein the alloy material is selected such that the inner core exerts a compressive strain on the outer shell.

Definitions

The following words and terms used herein shall have the meaning indicated:

The term "alloy material" is to be interpreted broadly to refer to a material which is a combination of two or more metallic elements in one or more metallic phases.

The term "lattice parameter" is to be interpreted broadly to refer to the distance between atoms of a unit cell. The term "lattice parameter" is used interchangeably with the term "lattice constant".

The term "lattice strain", when referring to a layer of material, is to be interpreted broadly to refer to strain of the crystal lattice in directions at least substantially parallel to the plane of the layer of material. Lattice strain can be compressive strain or tensile strain. When the crystal lattice is strained, the