Claims:

1. A method of depositing Pt containing nanodots on a catalyst support structure, preferably a catalyst carbon support structure, the method comprising the steps of:

a. forming a vapor of $Pt(PF_3)_4$,

b. exposing a surface of the catalyst carbon support structure to the vapor of $Pt(PF_3)_4$,

c. purging the surface of the catalyst carbon support structure with a purge gas to remove the vapor of $Pt(PF_3)_4$,

d. exposing the surface of the catalyst carbon support structure to a second reactant in gaseous form,

e. purging the surface of the catalyst carbon support structure with a purge gas to remove the second reactant,

f. repeating steps a. - e. to form a plurality of the Pt containing nanodots on the catalyst carbon support structure

wherein the temperature of the catalyst carbon support structure during step a. and/or step b. is from 50 degrees C to 300 degrees C, preferably from 100 degrees C to less than 200 degrees C, more preferably 100 degrees C to 175 degrees C or to less than 175 degrees C, such as 100 degrees C or 150 degrees C.

2. The method of claim 1, wherein the second reactant comprises an oxidizing agent selected from the group consisting of H_2O, O_2, O_3, NO_2, oxygen radicals and mixtures thereof; preferably O_2.

3. The method of claim 1, wherein the second reactant comprises a reducing agent selected from the group consisting of H_2, NH_3, SiH_4, Si_2H_6, Si_3H_8, SiH_2Me_2, SiH_2Et_2, $N(SiH_3)_3$, hydrogen radicals, hydrazine, methylhydrazine, amines, NO, N_2O, and mixtures thereof; preferably H_2.

4. The method of claim ~~1~~2, wherein the catalyst carbon support structure is not exposed to any additional reactants to form the plurality of the Pt containing nanodots on the catalyst carbon support structure~~wherein the second reactant is selected from the group consisting of H_2, O_2, and combinations thereof~~.

~~5. The method of any of claims 1–4, wherein the repetition of steps a.-e. is from 5 - 40 times.~~

~~6. The method of any of claims 1–5, wherein the plurality of the Pt containing nanodots are formed by an atomic layer deposition reaction.~~

~~7.~~5. The method of any of claims ~~1–6~~1 or 2, wherein the largest linear dimension of the nanodots has a range from 0.25 nm to 15 nm and/or a mean of 2nm - 7 nm.

~~8. The method of any of claims 1–7, wherein the catalyst support structure comprises multiple discrete particles having an outer surface and these discrete particles have a coverage of the Pt containing nanodots which is at least an average of 1 nanodot per nm^2 of the particle surface area after step f.~~

~~9.~~6. The method of any of claims ~~1–8~~1 or 2, wherein each Pt containing nanodot comprises sufficient Pt so that a) the atomic percentage of Pt for the catalyst carbon support structure with the plurality of the Pt containing nanodots is from 0.5% to 3%, preferably 1% to 2% and/or b) the weight percentage of Pt is from 5% to 50%, preferably 10% to 30%.

~~10.~~7. The method of any of claims ~~1–9~~1 or 2, wherein the catalyst carbon support structure is a catalyst carbon support structure, preferably containing at least 30% Carbon by weight.

~~11.~~8. The method of claim ~~10,~~7 wherein the plurality of Pt nanodots are formed directly on a carbon component of the catalyst carbon support structure.

~~12. The method of claim 10 or 11, wherein the catalyst carbon support structure is a single wall fullerene such as C_{60} and C_{72}, multiwall fullerenes, single wall or multiwall nanotubes, nanohorns, and/or has a density of about 0.2g/cm3 to about 1.9g/cm3 such as specialty carbons like VULCAN or Imerys' SUPER C65.~~

~~13. The method of any of claims 1–12, further comprising a step of exposing the surface of the catalyst structure to a third reactant in gaseous form, wherein, if the~~

~~second reactant is an oxidizing agent, the third reactant is a reducing agent, and vice versa.~~

~~14. The method of claim 13, wherein the step of exposing the surface of the catalyst structure to the third reactant, is separated from step d. by step e.~~

~~15. The method of claim 14, wherein the second reactant is oxygen and the third reactant is hydrogen.~~

~~16.~~9. A method of depositing Pt containing nanodots on a catalyst support structure, preferably a catalyst carbon support structure, the method comprising the steps of:

a. Forming a vapor of $Pt(PF_3)_4$,

b. Exposing a surface of the catalyst support structure to the vapor of $Pt(PF_3)_4$,

wherein step b. is for a time sufficient to form a plurality of the Pt containing nanodots on the catalyst support structure,

wherein the catalyst support structure is not exposed to any additional reactants to form the plurality of the Pt containing nanodots on the catalyst support structure, and

wherein the temperature of the catalyst support structure surface during step a. and/or step b. is from 50 degrees C to 300 degrees C, preferably from 100 degrees C to less than 200 degrees C, more preferably 100 degrees C to 175 degrees C or to less than 175 degrees C, such as 100 degrees C or 150 degrees C.

~~17.~~10. The method of claim ~~16~~9, wherein the largest linear dimension of the nanodots has a range from 0.25 nm to 15 nm and/or a mean of 2nm - 7 nm.

~~18. The method of claim 16 or 17, wherein the catalyst support structure comprises multiple discrete particles having an outer surface and these discrete particles have a coverage of the Pt containing nanodots which is at least an average of 1 nanodot per nm^2 of the particle surface area after step b.~~

~~19.~~11. The method of any of claims ~~16–18~~9 or 10, wherein each nanodot comprises sufficient Pt so that a) the atomic percentage of Pt for the catalyst support structure with the plurality of the Pt metal containing nanodots is from 0.5% to 3%, preferably

1% to 2% and/or b) the weight percentage of Pt is from 5% to 50%, preferably 10% to 30%.

~~20.~~12. The method of any of claims ~~16–18~~9 or 10, wherein the catalyst support structure is a catalyst carbon support structure, preferably containing at least 30% Carbon by weight.

~~21.~~13. The method of claim ~~20~~12, wherein the plurality of Pt containing nanodots are formed directly on a carbon component of the catalyst carbon support.

~~22. The method of claim 20 or 21, wherein the catalyst carbon support structure is a single wall fullerene such as C_{60} and C_{72}, multiwall fullerenes, single wall or multiwall nanotubes, nanohorns, and/or has a density of about 0.2g/cm3 to about 1.9g/cm3 such as specialty carbons like VULCAN or Imerys' SUPER C65.~~

~~23. A method of depositing Pt containing nanodots on a catalyst support structure, preferably a catalyst carbon support structure, the method comprising the steps of:~~

~~a. Forming a vapor of $Pt(PF_3)_4$,~~

~~b. Exposing a surface of the catalyst support structure to the vapor of $Pt(PF_3)_4$ and an oxidizing agent, concurrently,~~

~~wherein step b. is for a time sufficient to form a plurality of the Pt containing nanodots on the catalyst support structure,~~

~~wherein the catalyst support structure is not exposed to any additional reactants to form the plurality of the Pt containing nanodots on the catalyst support structure, and~~

~~wherein the temperature of the catalyst support structure surface during step a. and/or step b. is from 50 degrees C to 300 degrees C, preferably from 100 degrees C to less than 200 degrees C, more preferably 100 degrees C to 175 degrees C or to less than 175 degrees C, such as 100 degrees C or 150 degrees C.~~

~~24. The method of claim 23, wherein the oxidizing agent is selected from the group consisting of H_2O, O_2, O_3, NO_2, oxygen radicals and mixtures thereof; preferably O_2.~~

~~25. The method of claim 23 or 24, wherein the largest linear dimension of the nanodots has a range from 0.25 nm to 15 nm and/or a mean of 2nm - 7 nm.~~

~~26. The method of any of claims 23–25, wherein the catalyst support structure comprises multiple discrete particles having an outer surface and these discrete particles have a coverage of the Pt containing nanodots which is at least an average of 1 nanodot per nm^2 of the particle surface area after step b.~~

~~27. The method of any of claims 23–26, wherein each nanodot comprises sufficient Pt so that a) the atomic percentage of Pt for the catalyst support structure with the plurality of the Pt containing nanodots is from 0.5% to 3%, preferably 1% to 2% and/or b) the weight percentage of Pt is from 5% to 50%, preferably 10% to 30%.~~

~~28. The method of any of claims 23–27, wherein the catalyst support structure is a catalyst carbon support structure, preferably containing at least 30% Carbon by weight.~~

~~29. The method of claim 28, wherein the plurality of Pt containing nanodots are formed directly on a carbon component of the catalyst carbon support.~~

~~30. The method of claim 28 or 29, wherein the catalyst carbon support structure is a single wall fullerene such as C_{60} and C_{72}, multiwall fullerenes, single wall or multiwall nanotubes, nanohorns, and/or has a density of about 0.2g/cm3 to about 1.9g/cm3 such as specialty carbons like VULCAN or Imerys' SUPER C65.~~

~~31. The method of any of the preceding claims, wherein the plurality of Pt nanodots comprise face-centered cubic Pt crystals.~~

~~32.~~14. The method of any of the preceding claims, wherein the Utilization Efficiency is from 30 weight percent to 99 weight percent, preferably at least 50 weight percent, more preferably at least 75 weight percent, such as 50 weight percent to 90 weight percent or 75 weight percent to 80 weight percent.