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Nano Catalysis & Processes Fuel Cell Powered Hearing Aids

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Centre for Nano Production and Micro Analysis
Danish Technological Institute**



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Creating value since 1906

For more than a century the Danish Technological Institute has been involved in the technological evolution, making it one of the oldest of its kind in the world.





Services & work areas

Nano materials



Ink formulation



Printed electronics



Nano catalysts



Fuel cells & hybrid systems



Nano & micro analysis



Laser processing

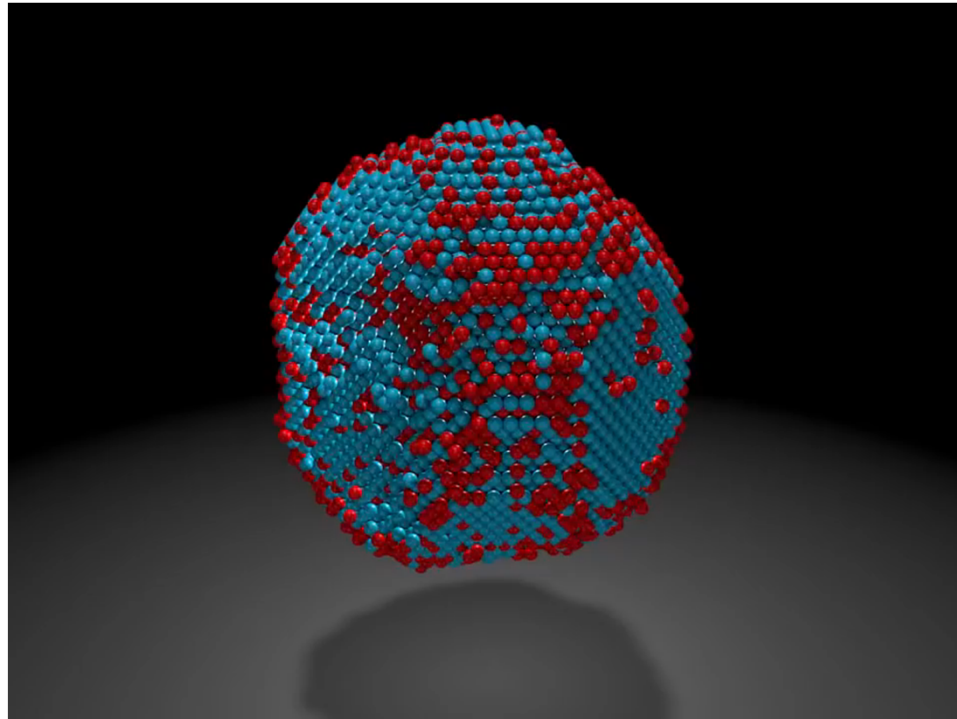


Nano coatings





Building nano materials by atoms



- Lawrence Berkeley Laboratory & Co Nature Paper in 2017
- 23.000 atoms in a single of 8.4 nm $\text{Fe}_{0.28}\text{Pt}_{0.72}$ nanoparticle
- They have determined the 3D coordinates of 6.500 irons and
- 16.500 platinum atoms in an iron-platinum nanoparticle (iron red)



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Real Materials, in Real Time, under Real Conditions



Danish Beam-line @ MaxLab IV in Sweden



Periodic Table

Production of nanomaterials in chemical society is a big issue!

Nanomaterials –
metal oxides, precious &
other metals

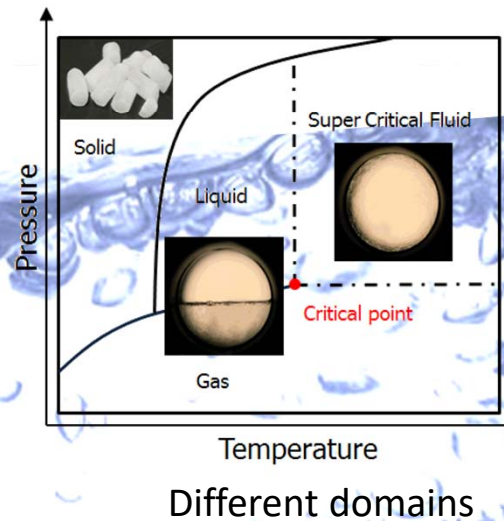
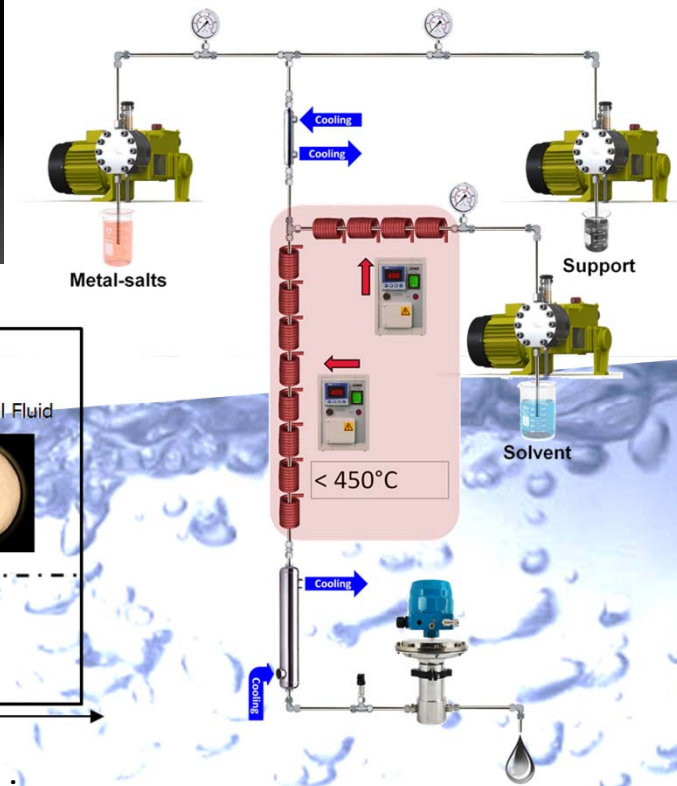
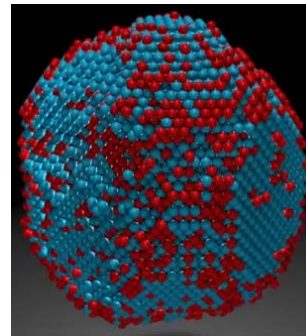
1 H Hydrogen	Production of nanomaterials in chemical society is a big issue!																2 He Helium	
3 Li Lithium	4 Be Beryllium	Nanomaterials – metal oxides, precious & other metals										5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon	
11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon	
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton	
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon	
55 Cs Cesium	56 Ba Barium	57-70	71 Lu Lutetium	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89-102	103 Lr Lawrencium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Uun Ununium	111 Uuu Ununium	112 Uub Unbium	114 Uuq Unquadium					
57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium					
89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium					



Super critical flow synthesis

Supercritical fluid advantages:

- Continuous one-step synthesis
- High pressure and temperature
(300-500 Bar; 250-450 C)
- Complex structures possible
- Supercritical fluids
- High control of nanoparticle properties





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Super critical flow production



Taping liquid
fx. 5 ± 0.5 nm

Production:
0.5 kg/ hour

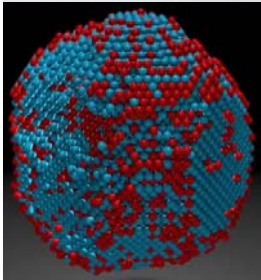
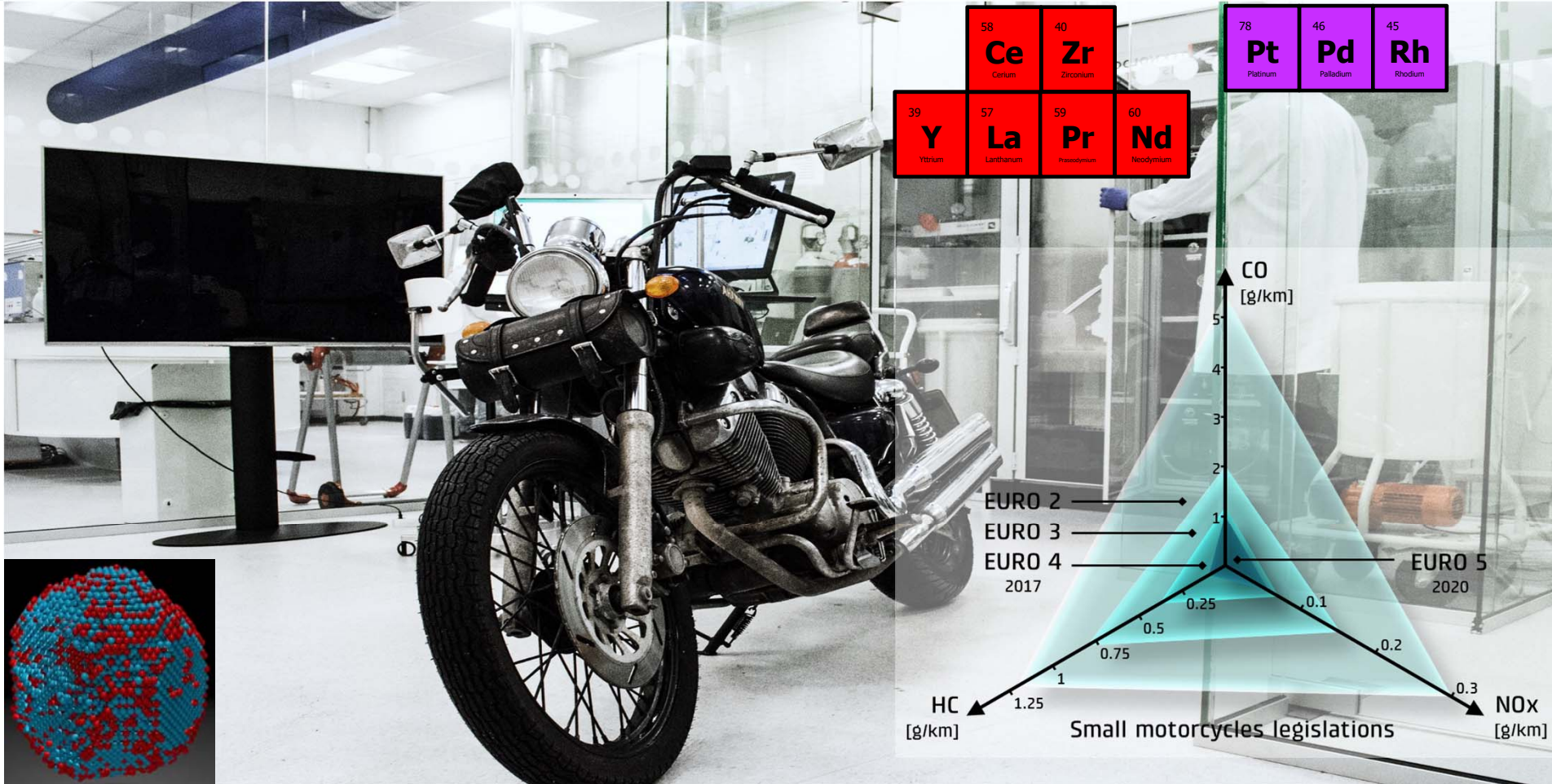


Nano liquid embedded in Monoliths





Three-way catalysts – motor bike

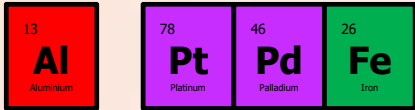




Diesel oxidation catalysts

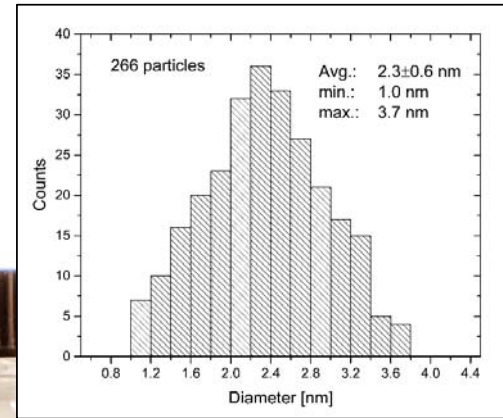
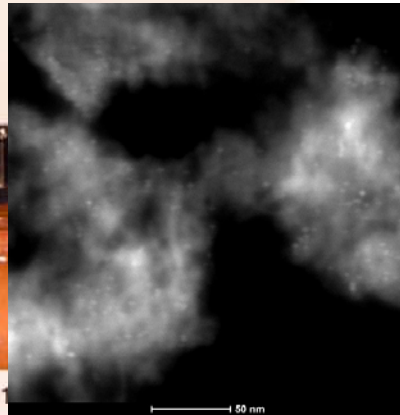
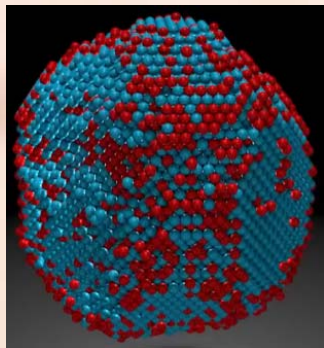
Objective: Lower PGM costs by Fe alloying

Small nanoparticles with narrow size distribution

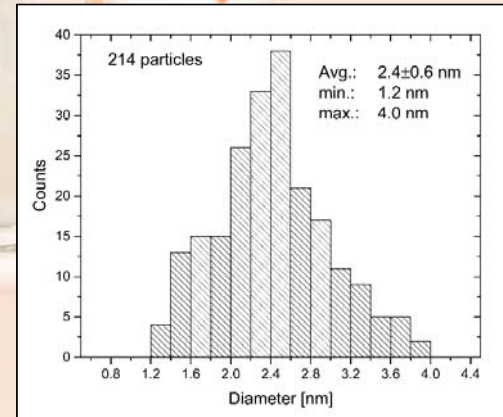
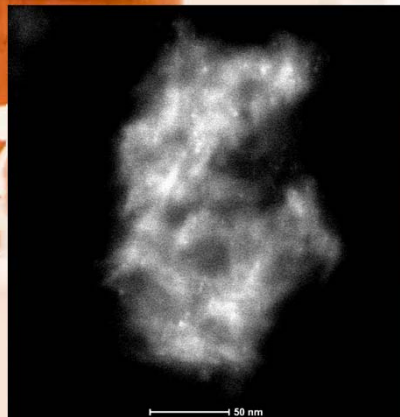


Diesel oxidation catalysts

Size distribution



PtPd₁/Al₂O₃

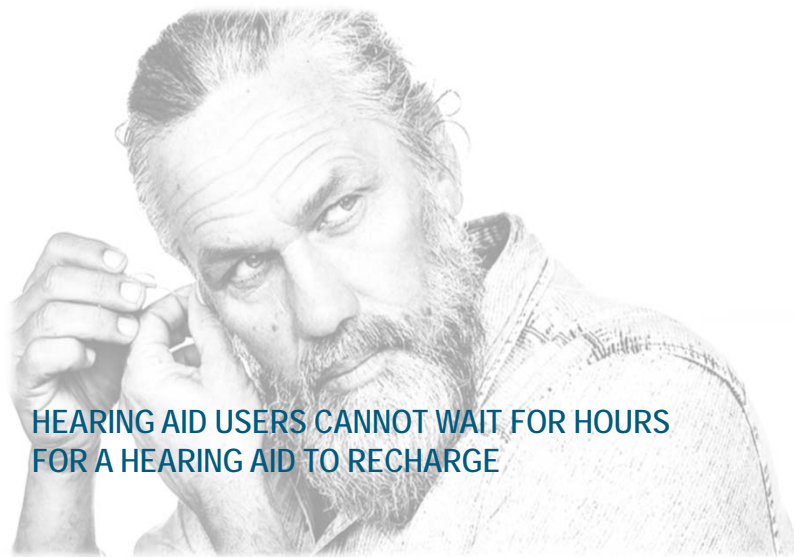


PtPd₁Fe_{0.3}/Al₂O₃



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A HEARING AID **POWER SOURCE** THAT CAN RECHARGE **INSTANTLY**



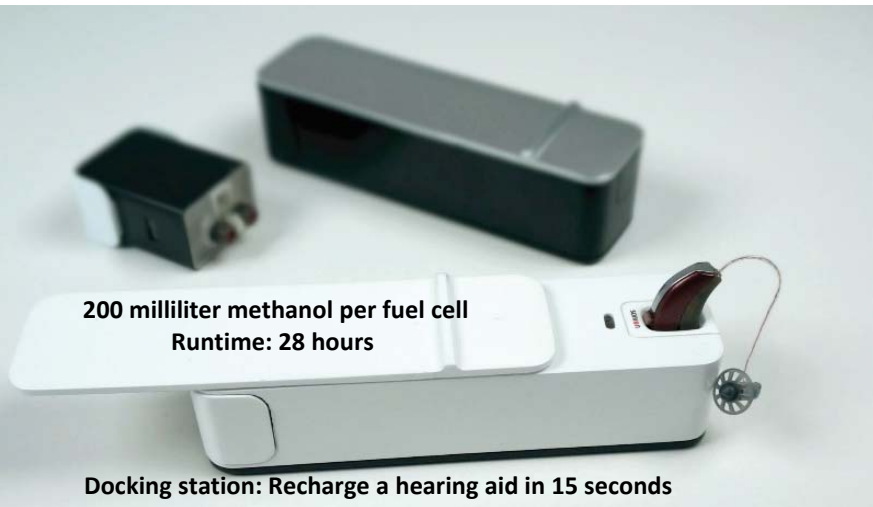
HEARING AID USERS CANNOT WAIT FOR HOURS
FOR A HEARING AID TO RECHARGE



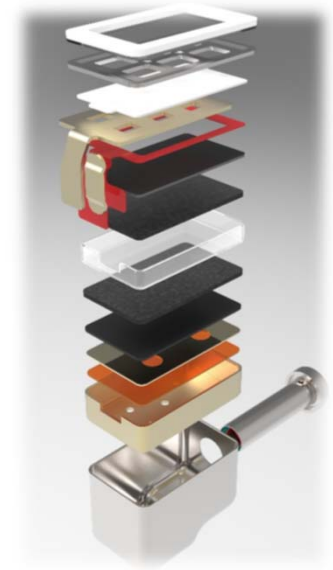
Soon ready to reach the market



Micro Fuel Cells



The smallest fuel cell in the world



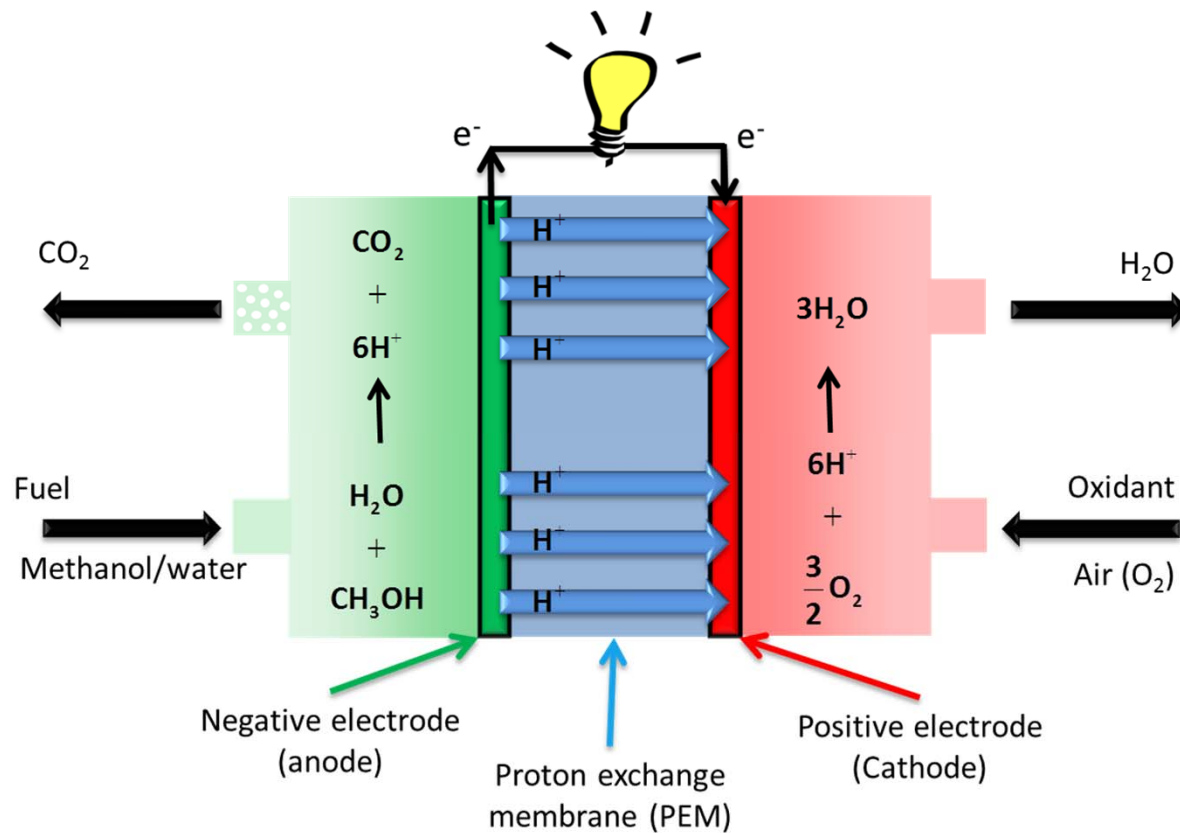
Exploded fuel cell

- Since 2009 DTI has developed the core technologies that enables fuel cells to replace batteries in hearing aids.
- DTI has invented the energy system.



The Passive Vapor feed Direct Methanol Fuel

Diagram - An alternative micro power supply



Methanol generate 0.5 V

DC/DC converter lift to 1.1 V



RECHARGEABLE BATTERY



WIDEX FUEL-CELL





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Thank you!

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