

Platinum Group Metal-free Direct Hydrazine Fuel Cell Vehicle

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Six meters cube is the total amount of platinum produced in the entire history of humanity, and it weights only about 4,000 tons. There is even a theory that even this has extra-terrestrial origin: a meteorite collided with the Earth about 2 billion years ago, and allegedly created a lava bed which is responsible for most of the platinum currently mined on our planet. We use platinum as exceptional catalysts for many processes and indeed the automotive industry is one of the three main areas that rely on platinum for performance. Platinum production in 2012 was 251 metric tons, of which 96 tons were used for the automotive emission-purification (catalytic convertor) catalyst. In addition to these 57 tons was recycled from the automotive catalyst creating a secondary market stream. It is evident that technical development for the reduction of platinum usage in the automotive industry is very important.

Preventing of global warming call for a set of technologies that will realize a new low carbon society. In a transportation sector, the biggest problem is that CO₂ sequestration is rather impractical, since CO₂ is emitted and released to the atmosphere from a huge number of automobiles in global diversity. It will be one of the effective solutions to spread zero CO₂-emission vehicles, such as electric vehicles (EVs) and fuel cell vehicles (FCVs), and to concentrate CO₂ capture on energy supply and electricity generation side. In particular, hydrogen fuel cell has been recognized as a viable platform for a efficient power source for vehicles. However, the socioeconomic problem associated with platinum, as a catalyst of choice, and the many restrictions associated with the filling and storage of hydrogen, are the two major barriers regarding the wide-ranging spread of FCVs.

The name of our project is *Creation of Anionic Fuel-cell for the Earth*, spelled as the “CAFE project”. The anion exchange membrane fuel cell (AMFC) vehicle has many advantages in support of a potential widespread of early adoption technology. Since the precious metals, such as platinum, are not needed at all, it is also very advantageous with respect to resources availability and economy of scale. Moreover, liquid fuel can be supplied safely using the existing infrastructure or a similar one with minimal alteration. Daihatsu Motor in alliance with a group of governmental, non-governmental, industrial and educational institutions, has introduced the concept of using hydrazine hydrate (N₂H₄·H₂O) as liquid fuel or “energy carrier”. By using

hydrazine hydrate a zero CO₂ emission from vehicles can be attained, since it is a carbon-free fuel. It is our vision that hydrazine hydrate, as a carbon-free energy carrier, can facilitate the realization of a true hydrogen economy.

In 2011 two “sister” models of direct hydrazine fuel cell (DHFC) vehicles were developed by Daihatsu. Both vehicles have been equipped with the new generation alkaline fuel cells using the anion exchange membrane, and have the big advantage of not using any platinum group metals in their design and components at all. The vehicle AMFC stack of 119 fuel cells generated a 12 kW output. The “elder sister” was converted into gull-wing specification prototype and was exhibited under the name “FC Show CASE” at the Tokyo Motor Show in December 2011 (see Fig. 1). The “younger sister” was a test model used in demonstration and testing and is running on Daihatsu grounds. It is expected that the AMFC with the non platinum group metal catalyst further expands the possibility for the spread of fuel-cell vehicles and opens an opportunity for market introduction.

The technical concept, materials and design solutions will be discussed, and an outlook to the performance characteristics of AMFC and their integration in the fuel cell vehicles will be given in the 224th ECS meeting.

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Figure 1: Daihatsu “FC Show CASE” the Platinum Group Metal-free Liquid Fuel Cell Vehicle as shown on the Tokyo Motor Show. All Rights Reserved by Daihatsu Motor Co. Ltd. & Dentsu Inc.