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Fuel cell versus battery electric vehicles: Global outlook

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Though development of batteries for battery electric vehicles (BEVs) is in continuous progress, they are still far from required performances such as heavy batteries occupy large space, self-discharge, complex manufacturing, and problem of recycling. Despite the progress of BEVs, travel range is twice lower than with conventional vehicle because of their imperfections in stored electricity. Tesla Model 3 has the range of 380 km with charging time of 40 minutes using the fastest charger. However, it is reasonable in EU to find chargers with 8-9 hours of charging time. On the other side, in fuel cell electric vehicles (FCEVs) the largest amount of energy for drive is stored in hydrogen storage that can be refueled within few minutes. Toyota Mirai has travel range of 560 km. Life cycle of FC stack is 7000-8000 of operating hours that is enough for automotive industry. Predictions of automotive industry are that the directions should go to the both BEVs and FCEVs. Small companies like Tesla Motors are developing just BEV and huge like Toyota and Honda are developing both. The main problem for FCEVs is the lack of hydrogen infrastructure. That is why consortia of world's car manufacturers, hydrogen companies and state services are creating with common goal of investment in hydrogen infrastructure. It seems that in the future we are going to have all generation of vehicles but however after 2025 it is expected to have decrease of conventional vehicles and increase of electric vehicles either BEVs or FCEVs at the same time.

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An overview on redox flow battery chemistry

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All-liquid flow batteries are suited for large-scale multi-hour applications because of the flexibility in decoupling of power and energy. Storing energy in the form of chemical redox in external tank makes the battery flow as the only electrochemical system that can be cost attractive for bulk energy storage. There are three types of flow batteries; the first one is based on simple soluble redox systems, such as V and Zn. The second generation is based on coordination compounds. This type is known as "coordination chemistry flow battery (CCFB)". And the third one is a hybrid between the solid-state battery and the liquid flow battery. This type relies on flowable electrode (slurry electrode) and is currently emerging as "semi-solid flow battery". All these systems can store and release electricity (duration depends on size of tank) almost instantly and have a high cycle efficiency. Most of the redox flow batteries are still not fully penetrated in the market due to high cost (total cost >$400/KWh) and large foot print as result of low volumetric energy density (20-30W/L). To improve the energy density and lower the cost, many research groups are focusing on chemistry of redox, electrolyte and electrode. In this talk, an overview on chemistry of redox flow battery will be presented and discussed. We will, in particular, shed light on challenges and opportunities in V-redox flow battery focusing more on electrochemical behavior of redox and electrode.

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