EDITORIAL

Nanotechnology application to direct liquid fuel cell

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The role of Nano-technology in electrochemistry is very significant, but it is possible that opportunities of this technology up to the present time it has not been realized completely. Especially it is connected to electrochemical energetics. Now electrochemical energetics mainly based on Li-ion batteries (and similar accumulators). At fact these powerful devices only transfer electrical energy from stationary sources to mobile ones. At the same time electrochemical generators (EG) are independent power sources for mobile application (mobile phone, electrical car and so on). EG or fuel cell (FC) with high energy density and high efficiency (up to 70-80%) is one of important part for new oil free energetics.

The FC technologies first started more than 100 years ago (W. Ostwald, W. Nernst), but even for now have practically only limited applications (space, submarines and so on). Reason is not only economics. In general catalysts of electrodes FC are only Pt (or Pt-group) metals. Commercially available batteries such as effective O_2/H_2 use Pt-catalysts and cylinders high pressure with O_2 and H_2, see for instance FT Bacon [1], Grubb and Niedrach [2,3], Ballard [4]. The technique is powerful and effective, but expensive and dangerous. At the same time H_2 as fuel is unique because of huge specific energy. Sources of hydrogen are not limited.

In last decades researchers focused on investigations of fuels based on safe and not expensive H_2 carriers (H_2 rich chemical compounds). See for example Amendola [5], Shukla [6], Korovin [7]. The main challenge now is to find new safety hydrogen carrier (fuel) and substitute traditional rare and expensive noble metal catalysts to low cost and efficiency metal or composite catalysts based on nanotechnology.

A R&D work in the field of FC is prospective on the way to oil free world. Several groups of researchers work in the field. Researchers Tanaka, Yamada, Asazava (from Daihatsu motor Co) reported about novel application of suggested of Korovin non noble metal catalysts such as Co and Ni [8,9].

At the same time there is another opportunity. Tel-Aviv University (TAU, prof. Patolsky, Dr. Filanovsky et al.) established that Cu in nano-form shows huge catalytic activity to oxidation of some amino-compounds. On base of the experimental results TAU chemists developed new fuel cell based on non-noble metal catalysts and amino-compounds as fuel, for example, ammonia-borane complexes, a borohydrides and hydrazine (and its derivatives) as fuel [10,11]. It was shown that low cost nano-Cu catalyst in the system works ca 1.5 times more powerful to classical Pt-catalyst [12-14]. It is shown that at high pH open circuit potential (ocp) on nano-Cu is -1.45 V, and ocp on nano-Pt is -1.0 V (vs Ag/AgCl, sat. KCl reference electrode). And accordingly potential of hydrogen evaluation (EH_2) on nano-Cu is in ca 1.5 times higher to ones of Pt. It was developed prototype of room temperature (RT) direct liquid fuel cell (DLFC). Result of testing the DLFC was positive. The cell works in non-stop regime in galvanostat regime more than 1000 hours (discharge current – 1.0 A) [15-17]. At the same time electrode from bulk (compact) Cu do not shows this effect. It is only one example of effect of application of nanotechnology in electrochemistry.

Examples show that investigations in the field of nanotechnology are the way to find nontraditional solutions on the way to other aspects of modern power sources. Now special interest is of investigations of micro fuel cell (bio-fuel cell). These cells can find broad applications in medicine as internal micro size power sources, for example for cardio stimulators. One of examples of such TAU work in field of biofuel cell (BFC) is described in Ref. [18]. It is one of the first attempts of investigation in BFC technology based on immiscible solvents. Indeed use in BFC (and FC) technology immiscible solvents allows dramatically simplifying cell design (separator is just not necessary). At the same time charge transfer through immiscible liquid-liquid border is new challenge in the searching the way to new energetic. The biofuel cell generates an open-circuit voltage, Voc, of ca. 1 V and a short-circuit current density, isc, of ca. 830 µA cm-2. The maximum electrical power, Wmax, extracted from the cell is 520 µW at an external optimal load of 0.4 kΩ. The fill factor of the biofuel cell, f=Wmax • Isc-1 • Voc-1, is ca. 60%. The bio-fuel cell based on bio-electro catalytic processes in two immiscible electrolytes shows a significant increase of the evaluated power in comparison with similar electro catalytic systems in a single-phase aqueous electrolyte [19-21].

And it is expedient to add that nanotechnology is the way to frontiers solutions; it can be very helpful not only in power sources technology and in sensors ones. Control and monitoring of dangerous and harmful substances is necessary in all part our life in medicine, food control, air and water pollution control and explosives and narcotics control. Reports about nanotechnology in sensors development will be next part of comments about applications of the technology in electrochemistry.

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