KOJE VEŠTINE SU POTREBNE U PROIZVODNJI LITIJUM-JONSKIH BATERIJA ZA ELEKTRIČNA VOZILA

WHAT SKILLS ARE NEEDED IN PRODUCTION OF LITHIUM-ION BATTERIES FOR ELECTRICAL VEHICLS

Zoran KARASTOJKOVIĆ*
Institut za hemijske izvore struje, Technoexperts, Beograd, Srbija

Baterije kao deo obnovljivih izvora energije uglavnom se koriste u električnim i hibridnim vozilima, dok su vetrogeneratori pogodniji za korišćewe u ruralnim sredinama. U međuvremenu, od 1990-tih, ovakve baterije su u velikom broju počele da se koriste u laptopovima, mobilnim telefonima i dr. U ovim baterijama, litijum-jon baterije su privukle veliku pažnju, kako u proizvodnji tako i korišćenju, kao punjive dnevno ili u bilo kojem nivou napunjenosti, nasuprot olovnim ili nikl-kadmijum baterijama.

U arhitekturi ovih baterija, mnogi anodni i katodni materijali su uključeni i primenjeni, uglavnom od oksida (kao što su: $LiCoO_2$, $LiMn_2O$, $Li(Ni_xMn_yCo_z)O_2$, zatim vanadium fosfati, čak i grafit ili još neki alkalni metali, idr.), što znači da je elektrohemija široko uključena u njihovu proizvodnju i primenu. Sa te tačke gledišta se javlja pitanje: šta je cilj u ogromnom broju studenata ekonomije, prava i/ili menadžmenta nad brojem studenata tehničkih nauka?

Ključne reči: *Punjive baterije, elektrohemijsa, broj studenata*

Batteries as a part of renewable sources of energy are preferably for using into electric and hybrid cars, while wind generators are particularly suitable for rural areas. In the mean time, from 1990, these batteries in a large scale came in use in laptop computers, mobile phones, etc. At those batteries, the lithium-ion batteries have attracted a great attention, both in producing and using, as rechargeable daily or at any state of using or charge level, in contrary to lead-acid or nickel-cadmium batteries.

In the architecture of these batteries, many anodic/cathodic materials are included and applyied, almost from oxides (as like: $LiCoO_2$, $LiMn_2O$, $Li(Ni_xMn_yCo_z)O_2$, furter from vanadium fosfates, even from carbon or some alkali metals, etc.), it means that the (electro)chemistry is widely incorporated in their production. From that point arises the question: what is our goal with a huge number of students on economy, law and/or management over the number of students on technical sciencies?

Key words: *Rechargeable batteries, electrochemistry, number of students.*

1 . Introduction

No doubt that the energy is one of the crucial factors for human life, and therefore is a subject of further researching and development. Renewable energy sources are dedicated for production of energy wich is collected from renewble sources as like sunlight, wind and geothermal heat, or other less important. Those energy sources serve almost for electricity generation and/or for water heating-up. Some types of electrical sources, as like wind generators, are particularly suitable for rural areas in developing countries, while batteries are preferably for electric cars.

Hybrid vehicles became popular, because they achive lower emissions than conventional combustion engines. But, it should be noticed that the internal combustion engine is better for maintaining high speed than electric motor.

Batteries in electrical cars are in using to power the electric motor or to power the hybrid electric vehicle, since the late of 1990s, when also came in use in laptop computers, mobile phones, etc. From that time to now, we have an opportunity to react as a state, first of all on the kind of profiles which

* Author's email: zoran.karastojkovic@gmail.com

will be educated, firstly for the production shedules of energy sources. Our answer, as a developing country, was resulted in dominance by number of students at economy, law and management over the number of natural or technical sciences. But, does this represents an usefull choice? Here will be given an effort in analysing the skills which are needed in production of renewable sources for electric cars.

2 . Short view on batteries for electric vehicles

In modern electric vehicles, the most common battery types are lithium-ion and lithium polymer, which posses high ampere-hour capacity and according that they show high energy density compared to their weight. Lithium-ion batteries usually are rechargeable, daily or at any state of using or charge level, in contrary to lead-acid or nickel-cadmium batteries. It should be noticed that motors on liquid fuels still have a greater *specific energy* (power to weight ratio) in comparison to batteries. Another task for such batteries is small weight, reducing the weight of the vehicle. So, are the economists, lawers or managers able to improve the performances of those batteries? They are able only to see that there are some batteries.., as could be seen from Fig. 1.

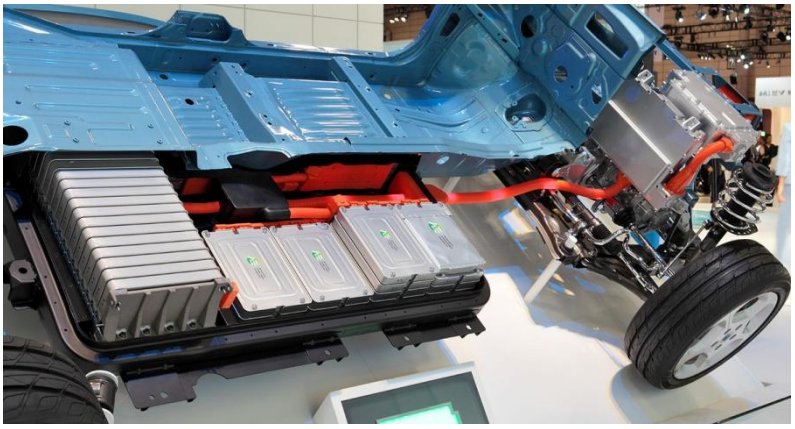

Fig. 1. One view on batteries in an electrical car

On that way they are only a *good buyer* and nothing more. But, the real question becomes: is the right choice only in importing and buying all kinds of goods? For trade, it is however quite enough. What about the employing of young people? Are they only the consumers of imported goods? Why we, as a state, continuosly educated in great scale proffesions which are unable to produce many of needed goods?

3 . Configuration and materials in lithium-ion batteries for electric vehicles

Common lead-acid batterries, nickel-cadmium, nickel–metal hydride, and less commonly were overgrowned on behalf of huge efforts/developments only by technicians but not from econimists, lawers or managers. The most known batteries now are based on lithium. Lithium-ion batteries in the first generation were designed on spinel structure and further on a layer structure.

Another criteria for assessing of battery capacity is the cruising distance, according to the amount of electricity stored in batteries is measured and expresed on a simple manner - in kilowat-hours, in Table 1. are shown results according to Nissan classification.

At almost cars still is the problem in starting during cold periodes, it means in winter. At freezing temperatures, the batteries lose their capacity, even a lithium-ion batteries. In these researches are included many of electrochemists, for descovering which materials are the most desired either as anode or cathode material. The electrochemical reactions are of the crucial role in all of those batteries.

Table 1. Crusing distance for various batteries (Nissan motor corporation)

Battery	Cruising distance (WLTC/JC08 mode)
24kWh	2010 (200km@JC08)
	2012 (228km@JC08)
30kWh	2015 (280km@JC08)
40kWh	2017 322km@WLTC Mode (400km@JC08 Mode)
62kWh	2019 458km@WLTC Mode (570km@JC08 Mode)

In simplified form, the scetch of Li/ion battery is shown in Fig. 2a) and its form in reality in Fig. 2b).

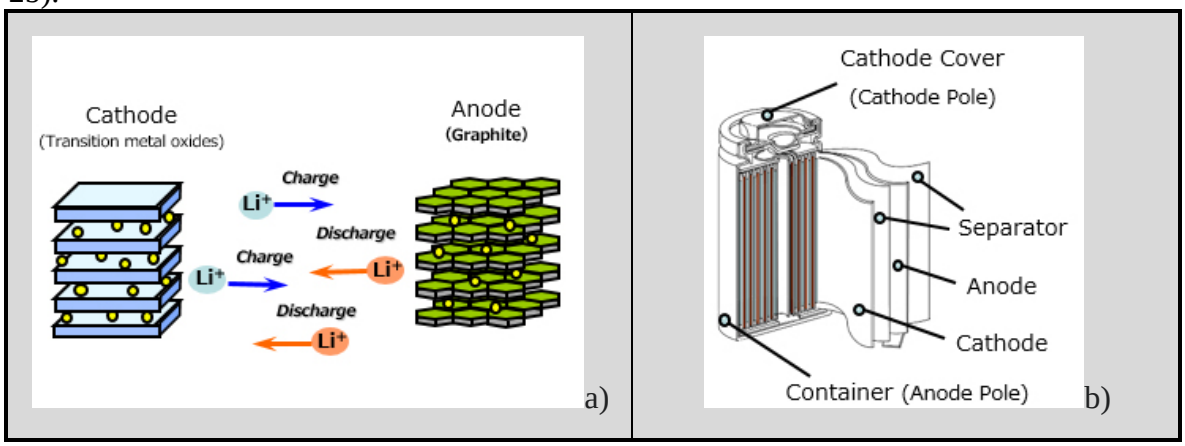

Fig. 2. Configuration of Li-ion battery with graphite anode a) and in 3D form b)

Short review of some other configurations and materials in lithium-ion batteries for electric vehicles are shown in figs. 3.

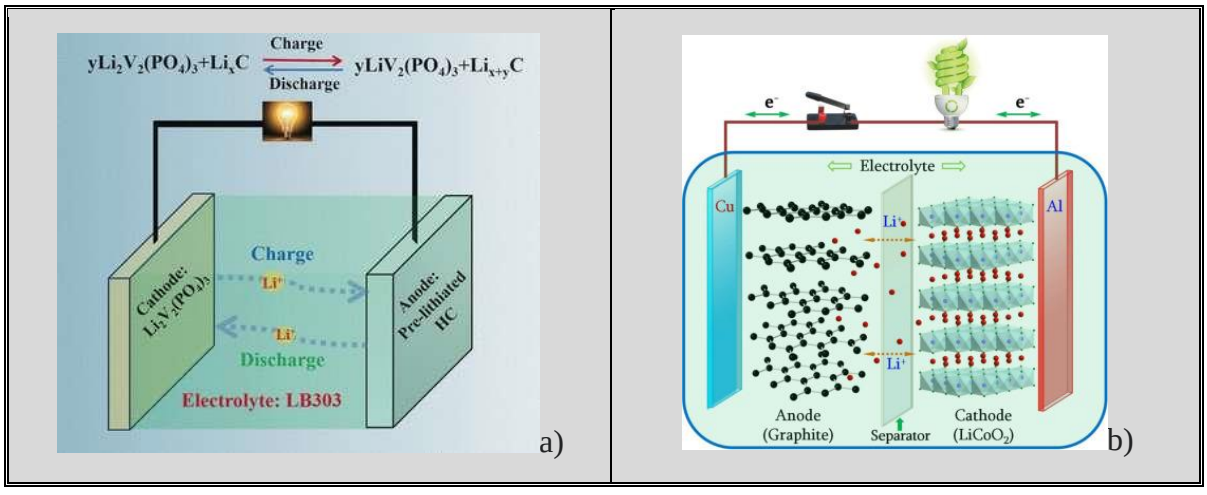

Fig. 3. Schematic diagrams of bateries with different materials for anode&cathode

However, one of the serious problems with lithium-air cells reported to date is that a solid reaction product (Li2O or Li2O2), which is not soluble in organic electrolyte, clogs the air electrode (cathode) in the discharge process. If the air electrode is fully clogged, O_2 from atmosphere cannot be reduced any more.

Another improvement is made by using the air instead of oxygen, Fig. 4.

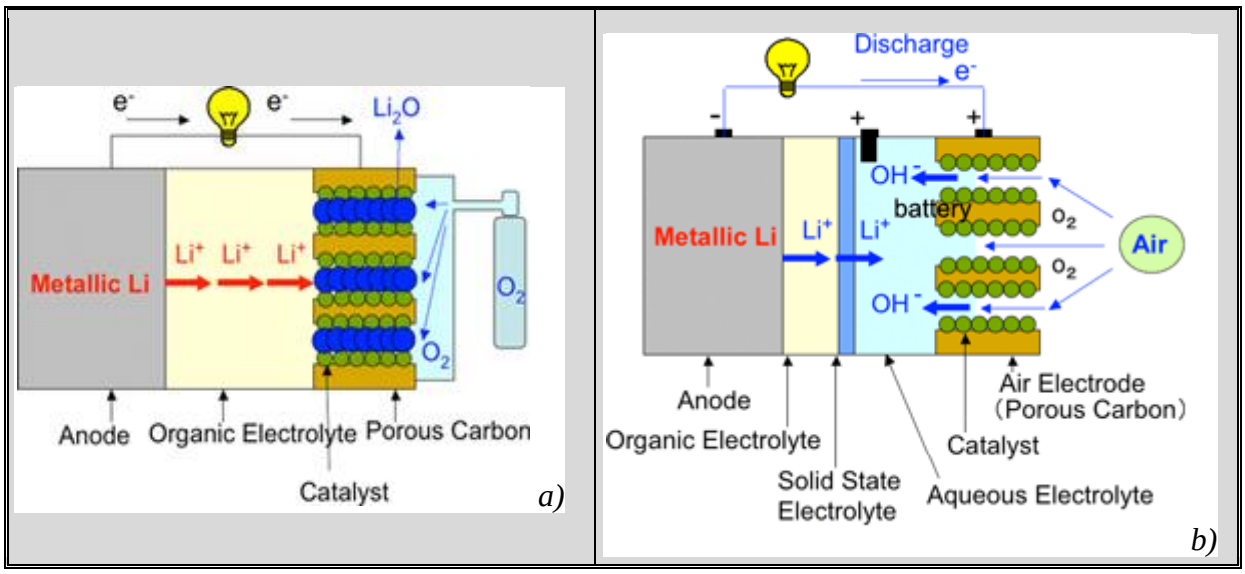

Fig. 4. Configuration of: a) conventional lithium-oxygen battery and b) new lithium-air cell b) Source: Japan's AIST (National Institute of Advanced Industrial Science and Technology)

Some of the main cathodic materilas in lithium batteries are on the oxide basis, as: $LiCoO_2$, $LiMn_2O$, or $Li(Ni_xMn_yCo_z)O_2$, Fig. 5, or furter vanadium oxides, etc. Carbon may be included in both electrodes, Fig. 5b).

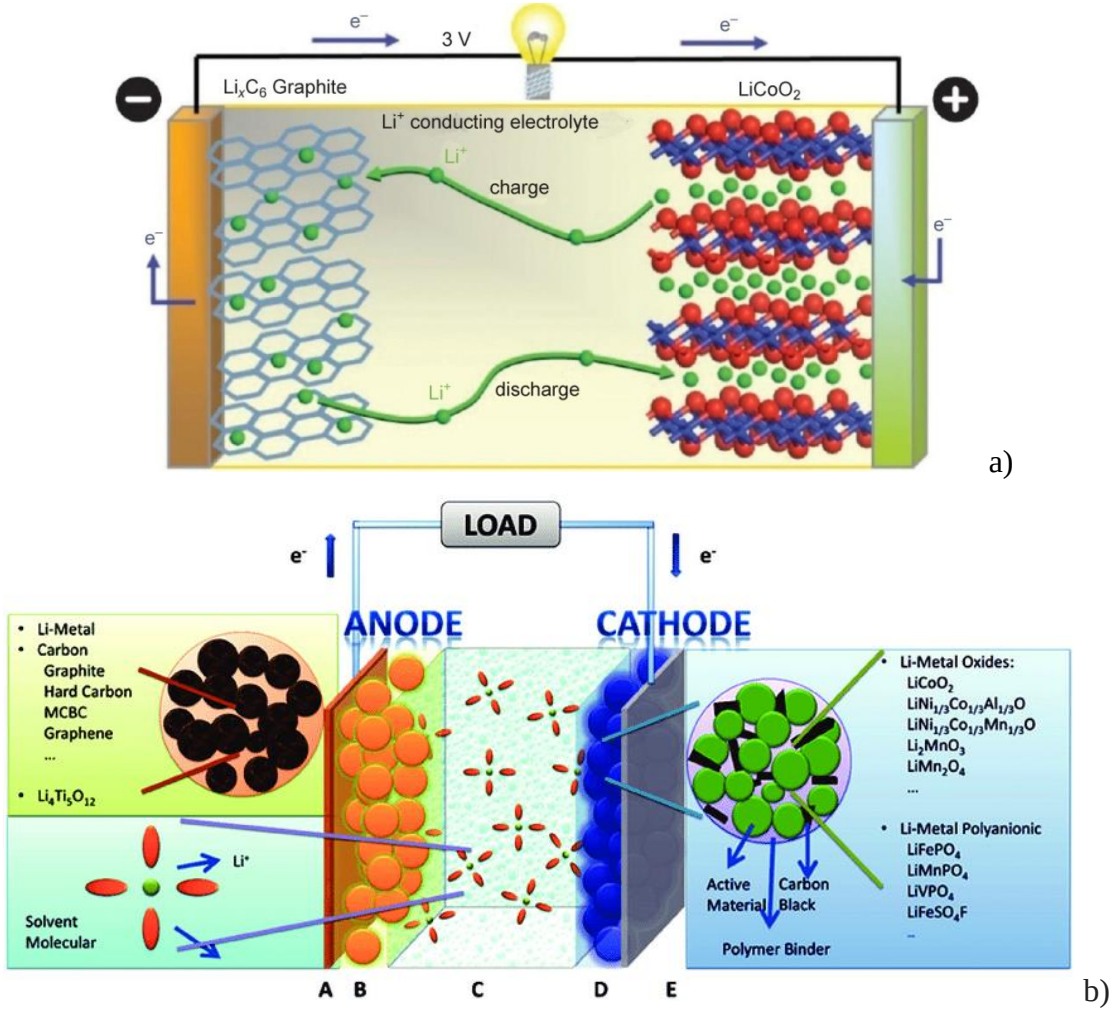

Fig. 5. More complex materials used for anode and cathode

4 Sodium-ion batteries are potential power technology of future

Betteries are constantly developing, one of the potential usefull design, with promising application in the future, is shown in Fig. 6.

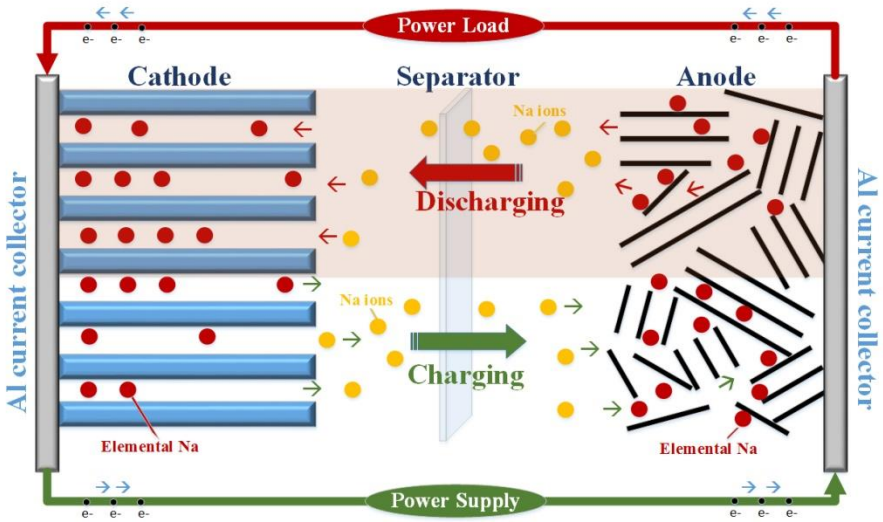

Fig. 6. One concept of battery based on sodium

Except of here presented, there are present a versatility in kinds of used materijals, both for anode or cathode.

5 Discusion

Lithium air battery is one of the most promising power technologies in the future because it has theoretical specific energies 100 times that of the state of the art Li-ion battery. One of the main obstacles in the development of Li-air battery technology is the stability of electrolyte. Here arises the question: is the stability of electrolyte the product of electrochemists or economists, lawyers and managers? For every step is needed many experiments in laboratories, about fast-charging, high volumetric capacity, etc. This is a real challenge for a society.

Most people even today know and use the lead-acid battery (accumulator), but from that time many improvements have happened. It is evident that any clever solution, from whatever discipline in human life, will not “fall from the sky”, just contrary - many efforts should be provided.

Some of the used materials might be harmful for environment and/or people. Batteries for electric vehicles should be characterized by their relatively high power-to-weight ratio. Also, they have to be small, for reducing the weight of the vehicle and therefore improve its performance. Compared to fossil fuels, most current battery technologies still have much lower specific energy, and a lot of work must be done.

6 Conclusion

The architecture of any kind of contemporary battery is not simple, just contrary. Many efforts must be involved in designing of every detail from battery, it means anode, cathode and electroyte chemistry. Without an adequate knowledge/skills from (electro)chemistry it is impossible to made any step in designing&production of batteries for electrovehicles, laptops, and similar equipment from our every day needs. Who will be at first identify and farhter produce the radically different methods or approaches for electrical energy storage? (Non)toxicity of used materials also must be the subject of any solution, it means after batteries will be spent.

In the mean time we will be convicted on economists, lawers, managers... in importing and buying the such goods. So, what is the target in the progress of society/state?

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