Abstract

The habilitation thesis in structured in 2 parts, using 10 articles indexed from Thomson Reuters along with 2 book chapters published by international publishing houses.

First part is shortly describing the main scientific, professional and academic achievements starting from the doctoral dissertation (March 2007) until today.

Approached research domains were aiming chemical engineering and because of the approached thematic I can also state that I also targeted environment protection domain.

Today's most important problem is the environment's incapacity of powering the growing global consumption – derived from industrial and household consumers.

During the development of last century's society – electrical energy production and transport issues were noticed and tracked.

There are more steps in electrical energy production using classical systems: first the fuels is burned – that's when the thermal energy is produced, and than this energy is used to produce steam. The resulted steam is injected into a turbine where the thermal energy is converted into mechanical energy, than using an electric generator it's transformed into electrical energy.

Burning fossil fuels releases CO_2, NO_x and SO_x in the environment – leading to serious ecosystem imbalances issues – inevitably affecting life on earth. This is why while still using and developing classical polluting energy producing devices – we should still work at developing environment friendly system that will produce electrical energy.

The IT explosion on the market (mobiles, laptops, mp3-players, cameras) is challenging producers to develop small sizes energy devices that will also be capable of supplying high density power and also be as environment friendly as possible. Developing and implementing mobile energy storage or production devices are also very important for isolated communities, where there is less or no access to electrical energy.

Therefore, although fuel cells have been regarded as taken from science-fiction literature, they stand as a possible clean electric energy prod gin system

In 1839 - W. Grove accidentally discovered the so called „gas battery" (Institution, 2004) – today known as fuel cells technology. The success that H_2/O_2 fuel cells gained during the Apollo and Gemini space missions – made them the ideal choice for solving above mentioned energy problems.

The advantage fuel cells offer compared with classical energy storage devices (that are now developed on global scale) is being able to continuously convert chemical into electrical energy, allowing the continuous system fueling with both oxidizing agent and fuel. Another advantage of fuel cells equipped with a solid polymer electrolyte is give by the fact that they can use an entire range of possible fuel types (hydrogen, alcohols, etc.) without the need to change the cells. Also, in the case of direct hydrogen fuel cells – the reaction product is represented by pure water – which can be a useful water resource.

In the case of fuel cells – the electric energy production is realized directly – without converting the thermal energy – fallowed by producing mechanical work. One can state that these devices are not affected by thermodynamic limitations we see in internal combustion engines, limitation defined by Carnot efficiency. By comparing the electric energy production in a single phase – with electric energy classical production systems – it is to be expected that the efficiency of fuel cells to be superior to classical systems.

For a better understanding of the actual development technology – I presented the direct hydrogen fuel cells functioning principle, for which it's been established a formula of calculating the tension at its terminals in ideal condition.

Also, based on this formula – the possible losses occurring in the real functioning system have been evaluated – while explaining the way these losses can be minimized, pursuing the increase of the energy efficaciousness of the considered system.

Starting from the classical technology of fuel cells as also from the goal of an advanced cleaning of residual waters and also due to the discovery of microorganisms capable of using an external electrons acceptor – the microbial fuel cells emerged.

These are electrochemical devices derived from classical fuel cells where platinum catalyst layers where replaced with biological catalyst layers and who allow

the organic matter conversion from used waters into electric energy while also cleaning them.

Starting point of the research was a cost reduction by replacing the platinum catalyst layers with catalyst layers builds with carbonic materials – as also by replacing the protons changing membranes with ceramic membranes.

This is how different carbonic materials were chemically activated and building catalyst layers which were afterwards tested in microbial fuel cells. Afterwards I build the microbial fuel cells where I replaced the polymeric membranes with ceramic membranes.

Another research domain is the obtaining of semiconductors applicable in thermoelectric production systems of electric energy. I considered this domain a priority because very big amounts of thermal energy are not used – therefore becoming residual energy.

During these experiments I synthesized and characterized the Zn_4Sb_3 conductor as also the way that Ag and Sn doping influence the properties of this material.

The second part of the habilitation thesis presents the planning and evolution of the teaching and research career. Thus, the future research directions are presented as a natural follow up of the research conducted so far.

The habilitation thesis is closing with 281 bibliographic references.