Prof. Dr. Tetiana PRIKHNA, Head of Department

Institute for Superhard Materials of the National Academy of Sciences of Ukraine Ukraine

Department of Technologies of high pressures, functional ceramic composites and dispersed superhard materials

The department's activities relate to the field of physical chemistry, physics and engineering materials sciences, development of new materials (heat resistant, superhard, superconducting, electro- and thermo conductive, thermal conductive, shock wave resistant, wear-resistant, with high absorption of microwave radiation and microwave-transparent , self-healing, smart, etc., nanopowders of metals, oxides, carbides and nitrides, diamonds, cubic boron nitrides), equipment and industrial technologies of their manufacturing; design and manufacture of the power units of vehicles, electromotors (superconducting, in particular).

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Reduction of transport vehical impact on air quality due to new conception of hydrogen storage and release on the board of transport vehicle and application of advanced materials and technologies.

CALL: GREEN VEHICLES

LC-GV-08-2020: Reducing the environmental impact of hybrid light duty vehicles

1. **The new conception of hydrogen production on the board of transport vehicle due to the reaction of metallic Al powder produced by the developed high productive electroerosion dispersion (EED) method with slightly alkaline water: *2Al + 2NaOH + 6H2O = 2Na[Al(OH)4] + 3H2↑ + 950.97 kJ/mol.***
2. **The developed EED method allows production of Al powder of 98% purity with spherical shape 0.05 - 3-5 microns particles (with near 8 vol.% of 0.05-0.1 μm particles), specific surface up to 120 m^2/gr (determined in accordance with the ISO 10076). The poly dispersed nature of the Al powder permits its dense packing *qua* PAS.**
3. **The presence of a nanofraction enables a short reaction induction period. It is mainly due to the presence of nanoparticles that the reaction response time is lowered from 7 to 2 s, which in the case of a transport vehicle will enable the essential volume minimization of the intermediate container. As a result of the reaction of one kilogram of aluminum powder more than 111 grams of hydrogen are released, which is equivalent to 1.23 m^3 of gaseous hydrogen (taking the hydrogen density to be 0.09 kg/m3 at 18 °C and 0.1 MPa).**

4. **The packed density of the aluminium powder was determined with the help of a Scott volumeter according to ISO 3923-2, and was found to be 1240 kg/m^3. From a volume of one litre filled with this powder, 1.52 m^3 of gaseous hydrogen can be obtained.**

Hydrogen can be stored in balloons at a pressure of 35 MPa. In conventional high-pressure balloons produced from carbon composites, in one litre it is possible to concentrate only 0.22 m^3 of gaseous hydrogen (ρH = 20 kg/m3). The pressure increase from 35 to 70 MPa will allow to increase the specific concentration of hydrogen up to 0.45 m^3 per liter (ρ_{H_2} = 40 kg/m^3 at P =70 MPa). The Detroit Autoshow, General Motors presented the "Sequel" concept-car, in which fuel balloons containing hydrogen at a pressure of 70 MPa were installed for the first time in an automotive vehicle and the car balloons contained a total of 8 kg of hydrogen.

Hydrogen can be stored in the liquid state when cooled to 20 K, but for hydrogen to be cooled to these temperatures, it is necessary to expend nearly one third of the chemical energy contained in it (11 kWh per kg H2); besides, the evaporation losses will amount to 3–5% per day. Other methods of hydrogen accumulation based on compression combined with the occlusion effect offer a hydrogen content of no more than 10 wt% (as a rule, more typically 4.5%)

5 **The systematic approach to reduce the heat dissipation and increase of efficiency will be realized due to the use of advanced thermoelectrical transformation systems and new type of propulsion engine.**

As a result of project implementation will be proposed :

- New concept of hybrid hydrogen-electrical light car with advanced thermoelectrical transformation systems
- The concept of rotary-type hydrogen internal combustion engine.
- Advanced propulsion system for hydrogen airplanes based on superconducting funs
- Technology and equipment for aluminum nanopowders manufacturing using method of electroerosion dispersion (EED)
- Manufacturing technology of superconducting and heat resistant materials with high functional performances.

Consortium and tasks

V. Bakul Institute for Superhard Materials of the NAS of Ukraine (NASU) , 2, Avtozavodskaya Str., Kiev 07074, Ukraine and Institute of Ecology and Alternative Energetic of the University "Ukraine", 1g Horiva Str., Kiev, Ukraine – proposition of new hydrogen electrical car, development of the new conception of propulsion hydrogen internal combustion engine worked base on hydrogen fuel produced using aluminum powder (in cooperation with Daimler) development of manufacturing technologies of Al powders using EED and advanced superconducting materials.

Daimler AG – transnational automobile concern - manufacturing and testing of new concept model

BOING company, Seattle, USA – development of airplane propulsion systems based on superconducting materials

Karlsruhe Institute of Technology (KIT), 76344 Eggenstein, Germany - development of the advanced thermoelectrical transformation systems

Technische Universität Ilmenau, Institute of Materials Engineering, Gustav-Kirchhoff-Strasse 6, D-98693 Ilmenau, Germany – investigation of the Al powders properties and the efficiency of hydrogen release.

Universite de Poitiers, CNRS/ Laboratoire PHYMAT, UMR 6630 CNRS Universite de Poitiers SP2MI, BP 30179, F-86962 Chasseneuil Futuroscope Cedex, France – development of the advanced heat resistant materials

Institute of Advanced Manufacturing Technology, 37A Wroclawska Str., 30-011 Krakow, Poland - development of 3d printing process of heat-resistant parts of vehicles/

Thank you for your kind attention!