Summary – general public

Depleting fossil fuel resources and constantly increasing environmental pollution force people to search for new solutions that will enable practical and rational use of renewable and ecological energy sources such as solar energy, wind energy, hydropower, and geothermal. The growing population in the world caused a rapid increase in energy demand, while 40% of the overall energy consumption in the world is connected to buildings. For this reason decarbonization of the building sector is crucial to mitigating climate change and for the building sector it is a great challenge to decrease energy consumption from the conventional sources that stimulate the development of sustainable, passive or buildings with net-zero energy. Renewable energy sources can be utilized in buildings in different ways, such as heating, cooling or electricity production in photovoltaic systems. Among all renewable energy sources, solar energy is considered the best option, as is the most abundant energy source of renewable energy and reaches the earth among others in the form of heat and light. Intensive research is being carried out on the development of systems allowing for the effective accumulation of thermal energy from renewable sources; the subject of growing interest are phase change materials (PCMs), in which phase transitions are used to thermal energy storage, in particular solid-liquid and solid-solid phase transitions. The use of latent heat of phase transition to thermal energy storage allows for the storage of a large amount of heat in a small mass and volume of the material. Among the various groups of PCMs, due to practical conditions, particular research interest is focused on materials with melting/freezing temperature in the range of 20-80°C from the group of organic and polymeric materials. However, all mentioned PCMs (poly(ethylene glycol) (PEG), fatty acids, fatty alcohols) in the context of using as PCMs possess some disadvantages - undergoes solid-liquid phase transition and they are characterized by low thermal conductivity. The thermal conductivity of PCM can be improved by introducing additives with high thermal conductivity directly into the PCM. On the other hand, to prevent leakage above PCMs melting point it is necessary to modify the PCM, by so-called shape stabilization. Hence, to avoid PEG leakage above their melting point different shape-stabilization strategies have been investigated including infiltration of melted PCM into porous materials. In recent years, the most promising material ensuring shape stabilization of PCMs are carbon aerogel, that are considered as the lightest substance in the world. Carbon aerogels are characterized by high electrical and thermal conductivity, and excellent sorption abilities. The 3D hierarchical microstructure with open pores in the aerogel allows penetration of ions/molecules into aerogel. This feature has made aerogels one of the most promising among all porous materials for many applications including gas sensing, catalysis, absorbents, and water cleaning, as well as with PCMs for thermal energy storage. However, currently solutions are being sought that will enable the effective use of PCM in various fields of technology, including PCM modifications to obtain multifunctional PCM–based systems. An example of such modification is the introduction of additives capable to absorbing and conversion of solar radiation to thermal energy, which after incorporation to PCM allows obtaining materials capable to conversion light to thermal energy and thermal energy storage. Recent literature reports show that promising effects of converting solar radiation into thermal energy in PCM can be achieved by using new materials, called MXene. MXenes are carbides and nitrides of transition metals that were described for the first time in 2011, and currently are a very fast-growing and already very large family of 2D materials with promising properties including photothermal conversion ability. On the other hand, porous carbon materials, including carbon aerogels, can be used to shape stabilization the of PCMs, which prevent them from leaking above the melting point of the PCM, and to improve the thermal and electrical conductivity of the obtained materials. Therefore, the aim of the project is to obtain and examine properties of new hybrid materials based on selected phase change materials (PCM) modified with MXenes and incorporated to carbon aerogels, capable to conversion of solar radiation into thermal energy and accumulation of the thermal energy.