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10.5 Single - molecule magnets as novel fillers with superior dispersibility – first application of a tetranuclear iron(III) molecular magnet $[Fe_4(acac)_6(Br-mp)_2]$ for pervaporative dehydration of ethanol

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Keywords: *single-molecule magnet, sodium alginate, hybrid membrane, pervaporation, ethanol dehydration.*

The novel composite Alg membranes containing molecular magnet (MM) were investigated in the process of water/ethanol separation. The obtained results were compared with the membranes loaded with magnetite and Prussian blue. We noticed that magnetic properties, hydrophilicity and compatibility between polymer matrix and MM have the most impact on the effectiveness of process.

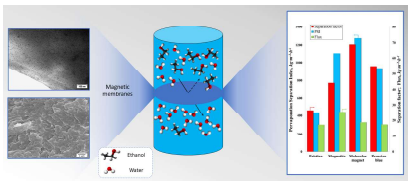

Figure 10.5.1: On the left side: SEM and TEM images; in the middle: the concept of water/ethanol separation through the membrane; on the right: the graph with the results of effectiveness of pervaporation procces with various fillers.

MM is a new class of magnetic materials. The advantage of MM, compared with traditional magnets is the ability to enhanced control over their dispersion in the polymer matrix. The research shows that powder of MM has a paramagnetic properties but in membrane it becomes a superparamagnetic. Superparamagnetism is related to a set of non-interacting particles containing magnetically coupled atomic magnetic moments. MM particles do not accrue, they are present in the membrane "everywhere" and there are no "gaps" through which the particles can flow without interacting with the magnets. This close contact between the magnet and the water particles is necessary for the interaction between the magnetic field created by the MM and water molecules. This situation is not observed in case of magnetite and Prussian blue.

The addition of various iron-based fillers increased the separation properties of composite alginate membranes and the best results were obtained in case of membranes containing 15 wt% of molecular magnet, for which the separation factor reached the value of 68.99; and PSI and 1275 kgm^2h^1.

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10.6 Study of the process of producing copper oxides nanoparticles by laser ablation in a liquid

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Keywords: *copper oxides nanoparticles, pulsed laser ablation in liquids, photoluminescence.*

Copper oxides nanoparticles (Cu_xO) have drawn substantial research attention due to their unique properties and, hence, the multitude of applications. Those materials exhibit favorable low toxicity, excellent antibacterial properties and low manufacturing costs. Both copper oxides (Cu_2O and CuO) absorb light in the visible spectrum and are p-type semiconductors. Therefore, Cu_xO nanoparticles can be used in photovoltaic devices, gas sensors, batteries or in hydrogen generation as catalysts for photochemical water decomposition.

The multitude of applications of Cu_xO NPs implicates the necessity of repeatable and efficient fabrication method for high-purity particles with designated structure and size. Popular chemical methods meet the criteria of process efficiency and repeatability, however, large amounts of toxic and difficult to separate by-products are obtained.

Pulsed Laser Ablation in Liquids is the remedy for as-indicated fabrication issues. This method provides pure nanomaterials due to the absence of chemical precursors. Generally, onestep ablation in oxidizing media is used to produce copper oxides. However, this approach has several limitations, restricting the recognition of the mechanism of copper oxides nanoparticles formation. Firstly, large amounts of highly oxidizing liquid may cause the surface oxidation of the source of the material (i.e. target) and promotes interaction of the laser beam with the environment leading to a mixture of various copper oxides and secondary products. Moreover, the composition of obtained colloids changes in time due to instability of some products (e.g., Cu_2O oxidizes to CuO). Furthermore, there are some mutually exclusive requirements for nanoparticles generation and fragmentation.

The improvement of the process of laser ablation through its division into two distinct stages with suitable parameters is proposed. The adaptation and optimization of the twostep ablation should provide stable copper oxides nanoparticles and aims to characterize their morphology, structure and optical properties. The principal research aspect is to analyze the Cu_xO properties in terms of oxidizing media (i.e. ethanol, water, hydrogen peroxide) and laser beam parameters in each synthesis step. Additionally, the effect of changing liquid media among stages is studied. Copper oxides nanoparticles are also examined in respect of stability and the influence of synthesis parameters on particles size.

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