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LASER-PROCESSED METAL/POLYMER COMPOSITES: APPLICATION IN CLEAN ENERGY, ELECTRONIC DEVICES, AND SENSORS

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Nowadays, the increasing intention of people to improve life quality and focus on sustainable development results not only in shifts in the way of thinking, but also simultaneously leads to the changes in technologies that affect everyday life. That means that the new approaches and materials need to be significantly improved and reconsidered to satisfy the modern demands, including zero-waste production, eco-friendly materials, individual health tracking systems, personal protection, and clean energy.

In this regard, we propose the fabrication of the composites that are flexible, inexpensive, have high and tunable electrical conductivity and show impressive mechanical resistance as a platform to fulfill all of these requirements (Figure 1). [1] Such composites are fabricated while robust laser integration of metal micro- and nanopowders (aluminium, silver, iron etc) into widespread polymers like polyethylenterephthalat (PET). Laser treatment is the most beneficial way for this purpose as it is less energy consuming, could be tuned in terms of applied power and wavelength of influence, and it is the excellent choice for the fabrication of arbitrary-shaped patterns with adjustable spatial resolution. While laser irradiation there are several key processes that take place, namely: local melting of PET, integration of metal NPs and their oxides to the top PET layer (about 50 µm), oxidation of metallic particles caused by bonding to polymer oxygen functional groups, the formation of carbide phase because of the high local temperature, and finally, the formation of laser-induced graphene that significantly contributes to the conductivity.

The obtained robust structures are promising not only as conductive patterns, but also as sensor platforms for such applications as flexors, electrothermal heating elements, and electrochemical sensors which were shown in our work.

What is also important and significant to the future implication of our composites is that they are flexible in terms of components content and also could be functionalized with additional elements and complex compounds. For instance, copper is a great option as one of the best catalytic materials,

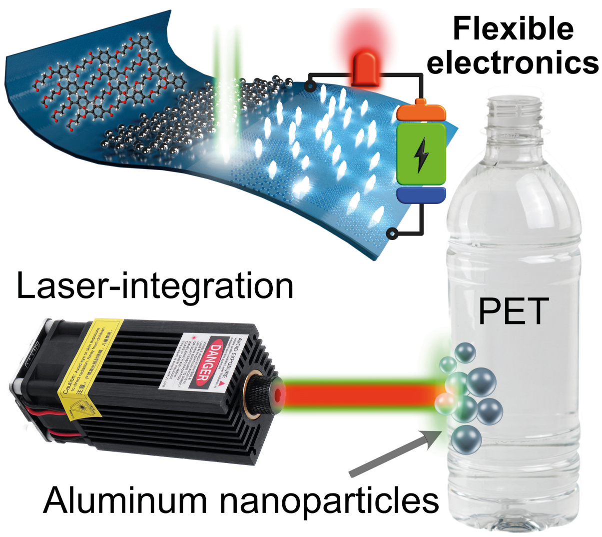

Fig. 1. *A schematic illustration of the technology of laser integration of metal nanoparticles to the polymer structure*

and its combination with polymers already showed an opportunity to convert CO_2 to CO, ethylene and other products using electrochemical and photochemical approaches [2, 3]. That makes our technology promising for the purposes of catalysis and clean energy production.

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ANALYSIS OF THE FORMALIZED HYDROCARBON COMPOSITION FOR THE PRODUCTS OF C_5–C_7 HYDROCARBONS PROCESSING ON ZEOLITE

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Search technologies and techniques that increase the depth of processing of hydrocarbon feedstock, are one of the priorities of the modern oil and gas industry. The involvement of stable gas condensate in the processes of motor fuel production is a possible way to get closer to the solution of this problem.

Stable gas condensate is a liquid blend of hydrocarbons from which low molecular weight (C_1–C_4) compounds are removed, at the same time normal C_5–C_7 paraffins are a major part of stable gas condensate.

The aim of this work is analysis the formalized hydrocarbon composition of n-pentane, n-hexane, and n-heptane processing products using the zeolite catalyst.

The processing of normal C_5–C_7 paraffins (zeoforming process) was carried out with technological parameters: temperature of 375 °C, pressure of 0.25 MP, feedstock volumetric flow rate 2 h^{-1}. The process products compositions were received by gas-liquid chromatography method in accordance with [1]. Some individual components from composition lists were aggregated based on the similarity of physicochemical properties into subgroups. The formalized compound list of normal paraffins C_5–C_7 processing products received as aggregation result (Table).

Results interpretation

1. The maximum propane yield is observed in the zeoforming process of n-hexane, which can be explained with its formation as a result of the breaking of the C–C bond in the middle of the n-hexane molecule.
2. N-pentane processing products have significant content n-pentane. Presumably, the temperature of 375 °C is not enough for the effective realization of the primary reactions of the cracking of n-pentane.
3. The olefins yield increases with an increase in the molecular weight of the feedstock, which is explained by a decrease in the activation energy of the cracking reaction of paraffins in the series n-pentane, n-hexane, n-heptane.
4. The yield of heavy C_{9+} n-paraffins and aromatic compounds increases with an increase in the molecular weight of the feedstock. These observations can be explained by the increasing role of the hydrogen transfer in olefins reaction, the result of which is the n-paraffins and aromatic compounds formation [2]. The high yield of n-paraffins C_{9+} can be associated with the equalization reaction rates of their formation and thermal decomposition.
5. The butanes yield decrease with an increase in the molecular weight of the feedstock. The iso-