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Prospects of catalytically-induced decomposition of methane to produce core-shell structured contrast agent for medical imaging

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Contrast agents (CA) are a well-established type of chemicals, used to enhance the contrast of tissues or vessels screened with non-invasive medical imaging modalities, such as computed tomography and magnetic resonance imaging, when introduced inside the body. Although many commercially available CAs are made of metal atom and chelate molecule, there is another promising composition of CAs, suggesting the use of metal nanoparticles incorporated in functionalized carbon or silica matrix, which enables targeted binding to given biomolecules, and consequently optimized biodistribution. However, nanoparticle-matrix CA composition does not provide as strong safety standards as atom-chelate composition, which diminishes toxic effects caused by a metal, in contrast to the first. Therefore, it is necessary for nanoparticle-matrix composition to additionally increase its metal safety and stability. One way to do it is to implement a core-shell approach, which consists in coating the metal nanoparticle with a uniform protective layer of chemically inert substance, thus protecting it from destructive bioprocesses. In this work, the synthesis of core-shell structured CA was attempted by means of catalytically-induced decomposition reaction of methane. The initial CA was prepared by ultrasonically-assisted impregnation of oxidized graphite nanoflakes in Lanthanum nitrate solution, followed by mild annealing the product in an inert atmosphere. The resulting composite was subsequently fluxed with methane to perform catalytic reaction of its decomposition into Hydrogen and elemental Carbon over Lanthanum nanoparticles, thus promoting deposition of carbon layers on their surface and forming core-shell structures. The properties of the composite before and after methane decomposition were probed and compared using various techniques, such as transmission electron microscopy, X-ray photoelectron spectroscopy, Raman spectroscopy. The core-shell CA, synthesized with described method, is expected to be investigated as a prototypical CA as part of pre-clinical research using computed tomography and phantoms.
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Primary authors: Mr KOZLOV, Aleksei (Lomonosov Moscow State University); Ms SUSLOVA, Evgeniya (Lomonosov Moscow State University); ROZHKOV, Vladislav (JINR)

Presenter: Mr KOZLOV, Aleksei (Lomonosov Moscow State University)

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