

# Technology offer

## Process for preparation of functionalized superparamagnetic adsorbents with precursor trimethoxy (1H, 1h, 2H, 2H-nonafluorohexyl) silane (NFHTMS)

### Field of use

separation and drying of air, removal of volatile organic compounds, cooling and air conditioning, water purification, remediation of nuclear waste

### Current state of technology

Stage of Development:  
Available for demonstration

### Patent status

Patent pending

### Developed by

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### Background

Classical methods of cleaning oil spills do not give satisfactory results in removing oil from water, but the functional nanomaterials show the potential to be able to become cost effective and environmentally friendly solutions. The invention is based on the problem of how to synthesize nanoparticles so that they will have such physicochemical properties that will be useful for the adsorption of oil stains / spills in water. The nanoparticles are supposed to have an iron oxide spinel crystal structure with a functional organic coating based on alkoxide precursors and should be small enough, single domain to exhibit superparamagnetic properties, meaning they are magnetically responsive in the presence of an external field but not permanently magnetized.

### Description of the invention

The main object of the invention is to prepare superparamagnetic iron oxide ( $\text{CoFe}_2\text{O}_4$ ) nanoparticles surface-functionalized with trimethoxy (1H, 1h, 2H, 2H – nonafluorohexyl) silane, the functionality of which allows the adsorption of oil stains from water with an adsorption capacity in the range of 2.0 – 4.0 g oil /g adsorbent, wherein a superparamagnetic core based on  $\text{CoFe}_2\text{O}_4$  iron oxide with a spinel crystal structure, permits responsiveness and conductivity of the entire adsorption nanostructure under the influence of an external magnetic field, regeneration and reuse of the adsorbent.

The global adsorbent market is estimated to exceed \$ 5,400 million by 2023, with CAGR estimates at more than 6.5% between 2018 and 2023. The global adsorbent market will experience significant growth due to strong demand for water treatment and uses in oil and gas refineries worldwide. In addition, adsorbents are basically used to maintain and improve chemical stability in many other applications.

### Main advantages

The adsorbents of the present invention are preferably intended to remove oil stains / spills from water, and their utility, due to the functionality of the superparamagnetic core porphine coating, also interferes with the removal of heavy metal ions and rare earth ions from water. A special feature of the invention is in the preparation and use of single-domain, superparamagnetic iron oxide nanoparticles. Superparamagnetic properties allow such nanoparticles to respond to an external magnetic field, but they are not permanently magnetized. Therefore, after adsorption, such nanoparticles can be removed (separated) from the medium by an external magnetic field, regenerated and reused in the next adsorption cycle, without losing their functional properties.