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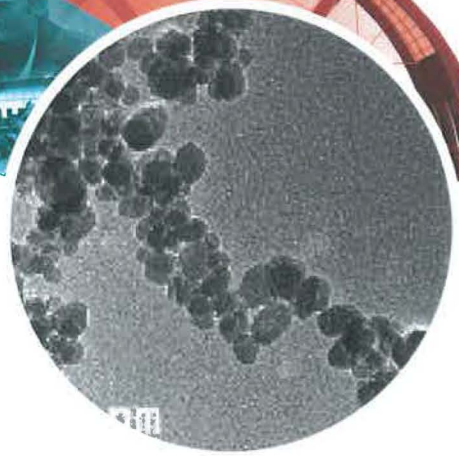


**INVENTORS**

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# MULTIFUNCTIONAL MAGNETIC CORE NANOPARTICLES


**Patent Search No.: S/UNIMAP/14MY43/GM**


## PROBLEM STATEMENT

- Needs for a nanoparticle that can be used for multifunctional applications.
- Green technology: needs for functional nanoparticles that can be recycled.

## PRODUCT DESCRIPTION

In this product, a magnetic material such as magnetite ($Fe_3O_4$) nanoparticles has been used as a core material. The functionality of this particles is multiplied by coating/combining with various functional nanoparticles such as silica, silver and silver chloride by a simple wet chemistry process, in the form of coreshell structures. Due to its good magnetic behavior, magnetite nanoparticles can act as an 'anchor' to direct the movement of the 'attached' functional nanoparticles by applying a magnetic field. Depending on the ratio of the materials used, and the way they are combined, it is possible to create applications for different needs.

## NOVELTIES

- The combination of 4 different functional nanoparticles (magnetite, silica, silver, silver chloride) under one particle system.
- Doping of 50 nm silver chloride nanocubes on silica surface.

## ADVANTAGES

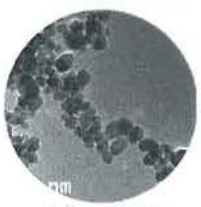
- Multifunctional magnetite nanoparticles can be recycled: reduced the re-production cost and support the green technology policy.
- The simple, room temperature synthesis is economically feasible: low production cost (time, energy, money).

## COLLABORATIONS

Aalto University
School of Chemical Technology, Finland

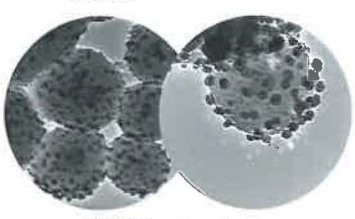
Institute of Physics, Academy of Sciences, Czech Republic

## PRODUCT

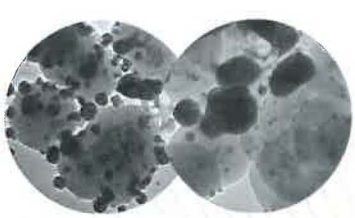


Magnetite nanoparticles

Magnetite-silica coreshell structure



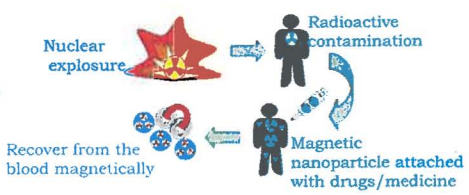
Magnetite-silica-silver



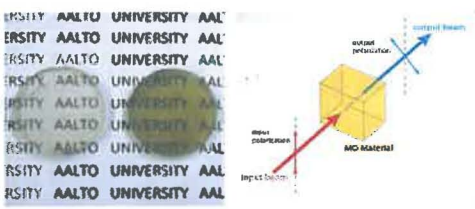
Magnetite-silica-silver chloride-silver

Magnetite-silica-silver chloride-silver

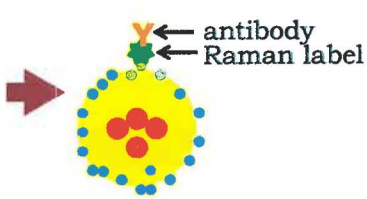
## COMMERCIAL POTENTIAL




1. Drug delivery



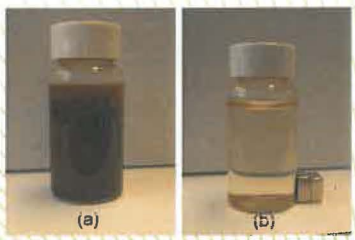

2. Magneto-optical media




3. Nanoprobe for biomedical application, nanobiosensor, antimicrobial activity

4. Photocatalyst, Antimicrobial activity

- Promote slow release of Ag+ for antimicrobial property
- As photocatalyst material – absorb in UV light
- Combine with silver: plasmonic photocatalyst – absorb in UV-Visible light




Reaction with magnet


**PUBLICATIONS**

1. **N. Mahmed**, O. Heczko, A. Lancok, S-P. Hannula (2014). The magnetic and oxidation behavior of bare and silica-coated iron oxide nanoparticles synthesized by reverse co-precipitation of ferrous ion (Fe2+) in ambient atmosphere. *Journal of Magnetism and Magnetic Materials*, 353, 15-22.
2. **N. Mahmed**, J. Larismaa, O. Heczko, M. E. Cura, S-P. Hannula (2013). Influence of sintering temperature on the properties of pulsed electric current sintered hybrid coreshell powders. *Journal of the European Ceramic Society*, 33, 2233-2239.
3. **N. Mahmed**, Oleg Heczko, Simo-Pekka Hannula (2013). Influence of hydrochloric acid concentrations on the formation of AgCl-doped iron oxide-silica coreshell structures. *Advances in Science and Technology*, 77, 184-189
4. **N. Mahmed**, H. Jiang, O. Heczko, O. Söderberg, S-P. Hannula (2012). Influence of different synthesis approach on doping behavior of silver nanoparticles onto the iron-oxide silica coreshell surfaces. *Journal of Nanoparticle Research*, 14, 987
5. **N. Mahmed**, O. Heczko, R. Maki, O. Söderberg, E. Haimi, S-P. Hannula (2012). Novel iron oxide-silica coreshell powders compacted by using pulsed electric current sintering: Optical and magnetic properties. *Journal of the European Ceramic Society*, 32, 2981-2988