Method for mass production of high performance magnetic nanoparticles for biomedical applications

Iron nitride nanoparticles are post-processed by applying a wet ball milling method in conjunction with different surface-active media and centrifugation steps to obtain ultra-stable, monodispersed, uniformly sized, surface-functionalized, and sub-100-nm iron nitride nanoparticles suitable for biomedical applications

IP Status: Provisional Patent Application Filed

Applications

Technology ID

2021-226

Category

Engineering & Physical Sciences/Chemicals
Engineering & Physical Sciences/Materials
Engineering & Physical Sciences/MRI & Spectroscopy
Engineering & Physical Sciences/Nanotechnology
Engineering & Physical Sciences/Processes
Life Sciences/Diagnostics & Imaging

Learn more

- Non-invasive, 3D magnetic imaging for disease detection, diagnosis,and treatment monitoring, such as magnetic resonance imaging (MRI) and magnetic particle imaging (MPI)
- Use as carriers for targeted gene and drug delivery for therapeutic purposes
- Use as heating sources in magnetic hyperthermia therapy
- Use as labels for magnetic separations in blood purification
- Use as magnetic labels in magnetic biosensors for disease diagnosis, genotyping, food and drug regulation

Key Benefits & Differentiators

- **Inexpensive, low biotoxicity, and environmentally friendly:** nanoparticles made of iron and nitrogen
- **High magnetic moment :** the saturation magnetization of γ′-Fe4N is around three times higher than conventionally used iron oxide nanoparticles (IONPs) of same sizes
- **Ultra-stable, monodispersed, uniformly sized, and sub-100 nm nanoparticles:** by applying a wet ball milling method along with different surface-active media, sonication and centrifugation steps to separate nanoparticle agglomerates and functionalize the surface with desired chemical groups
- **Compatible with current manufacturing processes to enable scale-up:** dry γ′-Fe4N nanoparticles produced by conventional methods are post-processed with a series of simple steps to yield uniform NPs with desired specifications

Technology Overview

Iron oxide nanoparticles (IONPs) are widely used in biomedical applications. However, there is an increased demand for magnetic nanoparticles (MNPs) with higher magnetic moments that can enable more sensitive magnetic diagnosis and lower dose treatments via magnetic bioassays, imaging, and therapies. To this regard, Iron nitride nanoparticles constitute a promising solution because their saturation magnetization is three times higher than that of IONPs, which corresponds to an estimated five to eight times higher sensitivity. However, the large and non-uniformly distributed sizes of γ′-Fe4N nanoparticles prevent them from being used in biomedical applications. Currently, there is no method capable of producing uniformly sized and surface functionalized γ′-Fe4N nanoparticles suitable for biomedical applications at scale.

Researchers at the University of Minnesota have developed a method that is capable of separating γ′-Fe4N nanoparticle agglomerates and functionalizing their surface with desired chemical groups, while also yielding ultra-stable, monodispersed, and uniformly sized nanoparticles. In this novel method, γ′-Fe4N dry nanoparticles produced by conventional manufacturing processes are separated and functionalized by applying a wet ball milling method along with different surface-active media. A follow-up centrifugation step is then used to effectively extract sub-100-nm and uniformly sized γ′- Fe4N nanoparticles from turbid suspensions. Thus, the proposed technology couples conventional NP manufacturing methods with post-processing steps to yield at-scale production of highly-stable, and uniform γ′-Fe4N nanoparticles suitable for biological and biomedical applications such as magnetic imaging, gene & drug delivery, magnetic hyperthermia therapy, magnetic separation, and magnetic biosensors.

Phase of Development

TRL: 3-4

The technology has been tested in laboratory settings

Desired Partnerships

This technology is now available for:

- License
- Sponsored research
- Co-development

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Researchers

- **Jian-Ping Wang, PhD** Distinguished McKnight Professor, Department of Electrical and Computer Engineering

References

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