

CIC biomaGUNE develops new nanomaterials for medical diagnostic imaging

Manganese-doped carbon nanodots show great potential as contrast agents for magnetic resonance imaging and could be the next generation of contrast agents

These nanoparticles of around 5 nm, developed in the laboratory headed by Ikerbasque professor Maurizio Prato, are easily eliminated from the body and are highly biocompatible

San Sebastian, 5 October 2026. Contrast agents are compounds that are routinely used in clinical analysis to enhance differentiation between the various tissues or to increase the visibility of structures or fluids within the body, thus facilitating medical diagnosis.

A study led by researcher [Lucia Cardo](#) and Ikerbasque research professor and AXA chair [Maurizio Prato](#) (both at CIC biomaGUNE) confirms that manganese-doped carbon nanodots could be the next generation of contrast agents for magnetic resonance imaging. The findings of the study published in the scientific journal *ACS Nano* reflect their great potential.

These new spherical nanoparticles developed in the [Carbon Bionanotechnology Laboratory](#) headed by Prato are approximately 5 nanometres in size (a nanometre is one billionth of a metre) and composed mainly of carbon, with a small amount of manganese. "Despite being present only in small amounts, the manganese is firmly integrated into the structure of the nanoparticle, so its properties can be exploited to provide exceptional contrast in MRI. In fact, its performance is comparable to current contrast agents, or even superior in some cases", states Cardo.

Safer, more effective and more sustainable contrast agents

Compounds containing gadolinium, a metal with magnetic properties that help highlight tumours, blood vessels or damaged tissue, are commonly used as contrast agents in MRI. Although these compounds have been essential for medical diagnosis for almost four decades, their use may pose a health risk for patients with kidney failure. They also contribute to the persistence of gadolinium in the environment, since they can enter wastewater and are difficult to eliminate during its treatment.

Therefore, safer and more sustainable alternatives are being sought. Currently under study is the use of metals considered safer and more abundant, such as manganese, which is also more cost effective than other heavy metals.

The aim of this study was to develop an initial manganese-doped carbon nanodot platform that would be stable, reproducible, well-tolerated and detectable using magnetic resonance imaging (MRI). "Despite the great potential of these materials and their numerous possible applications, achieving adequate stability and reproducibility remains one of the main challenges in translating them from research

to real-world biomedical applications. Through our work, as well as optimising synthesis, we have also (and importantly) established validation strategies that allow us to obtain a truly reliable and reproducible material”, commented Cardo.

“An important contribution of this work was that the nanodots could be detected in their natural form using MRI”, says CIC biomaGUNE researcher Michele Cesco, lead author of the paper, “without having to first add a molecule that targets them toward a specific organ or tissue, something that usually contributes to their accumulation and, hence, their detection.”

Studies using animal models show that the nanoparticles are efficiently eliminated from the body and are highly biocompatible, even after long-term studies. Once good contrast-agent performance had been achieved; that is, a very high detectability using traditional MRI, comparable to that of commercial contrast agents, “we were able to study the behaviour of the material itself. For example, we studied how the material behaved over the long term, in both cells and animals, and observed adequate biodistribution and rapid elimination from the body, without detecting any significant toxic effects on the main organs analysed”, added Cardo. The results support their potential as next-generation manganese-based contrast agents, since they offer efficacy, stability and safety.

There is a growing need in medicine for increasingly versatile contrast agents that can be used in different imaging techniques, such as magnetic resonance imaging and positron emission tomography (PET), and can also combine diagnosis and treatment. The nanoparticles designed at CIC biomaGUNE have fluorescent properties, opening up the possibility of also using them with other detection techniques and combining different imaging modalities in the one particle.

In general, carbon nanodots have great potential for theranostics (diagnosis and therapy combined) applications; that is, combining in the same platform the ability to detect and to treat a disease. The next step is to move forward in this direction: “We are working to retain the high MRI detection capabilities and to add new functions that allow the nanoparticles to be targeted to certain diseases, such as cancer (and detect it using MRI), and the incorporation of a therapeutic action. In particular, we are working on light-activated therapeutic functions, and the results are looking very promising”, concluded the researchers.

Bibliographic reference

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About CIC biomaGUNE

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