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Iron-Reduced Graphene Oxide Core–Shell Micromotors Designed for Magnetic Guidance and Photothermal Therapy under Second Near-Infrared Light

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Citation: Donoso-González, O.; Riveros, A.L.; Marco, J.F.; Venegas-Yazigi, D.; Paredes-García, V.; Olguín, C.F.; Mayorga-Lobos, C.; Lobos-González, L.; Franco-Campos, F.; Wang, J.; et al. Iron-Reduced Graphene Oxide Core–Shell Micromotors Designed for Magnetic Guidance and Photothermal Therapy under Second Near-Infrared Light. *Pharmaceutics* **2024**, *16*, 856. https://doi.org/10.3390/pharmaceutics16070856

Academic Editors: Ana Isabel Fraguas-Sánchez, Raquel Fernández García and Francisco Bolás-Fernández

Received: 14 May 2024
Revised: 17 June 2024
Accepted: 20 June 2024
Published: 25 June 2024

Abstract: Core–shell micro/nanomotors have garnered significant interest in biomedicine owing to their versatile task-performing capabilities. However, their effectiveness for photothermal therapy (PTT) still faces challenges because of their poor tumor accumulation, lower light-to-heat conversion, and due to the limited penetration of near-infrared (NIR) light. In this study, we present a novel core–shell micromotor that combines magnetic and photothermal properties. It is synthesized via the template-assisted electrodeposition of iron (Fe) and reduced graphene oxide (rGO) on a microtubular pore-shaped membrane. The resulting Fe-rGO micromotor consists of a core of oval-shaped zero-valent iron nanoparticles with large magnetization. At the same time, the outer layer has a uniform reduced graphene oxide (rGO) topography. Combined, these Fe-rGO core–shell micromotors respond to magnetic forces and near-infrared (NIR) light (1064 nm), achieving a remarkable photothermal conversion efficiency of 78% at a concentration of 434 μg mL^{-1}. They can also carry doxorubicin (DOX) and rapidly release it upon NIR irradiation. Additionally, preliminary results regarding the biocompatibility of these micromotors through in vitro tests on a 3D breast cancer model demonstrate