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(57) Abstract :

This system introduces a novel class of photo-responsive metal-organic framework (MOF) based nanocomposites engineered for near-infrared (NIR)-controlled drug delivery in targeted therapy. The system integrates Zr-based MOPs (Ui0-66 derivatives) functionalized with NIRabsorbing plasmonic nanoparticles, such as gold nanorods, to achieve precise photothermal responsiveness. These nanocomposites are designed to address challenges in traditional drug delivery systems, including non-specific release, poor targeting efficiency, and systemic toxicity. The MOF scaffolds provide a high surface area and tunable porosity, facilitating efficient encapsulation of therapeutic agents such as doxorubicin. Under NIR irradiation, the plasmonic nanoparticles generate localized heat, disrupting the MOF framework or activating thermosensitive linkers, thereby triggering the on-demand release of the drug. This process is optin1ized for minimal off-target effects by leveraging the deep tissue penetration capability of NIR light and the enhanced permeability and retention (EPR) effect in tumor tissues. Extensive in vitro studies confirm controlled drug release kinetics and cytotoxic effects on cancer cells with negligible impact on healthy cells. In vivo experiments conducted on murine tumor models demonstrate significant tumor regression, reduced systemic toxicity, and enhanced survival rates compared to conventional chemotherapy. Additionally, the biodegradability of the MOF matrix ensures safe clearance from the body post-therapy.

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