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Responsive Metal–Organic Frameworks Encapsulated Tellurium Nanodots for Cancer Therapy and Controlled Drug Release

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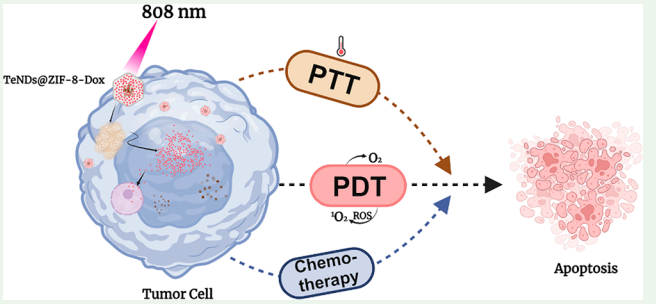
ABSTRACT: Cancer represents a persistent global health challenge, and the inherent limitations of chemotherapy are widely acknowledged. Notably, there is growing interest in multifunctional core–shell nanostructures as promising candidates for diverse biological applications. Herein, we have successfully devised a biocompatible zeolitic imidazolate framework-8 (ZIF-8) coated onto multicore Tellurium nanodots (TeNDs) nanocarrier (MOFs@TeNDs). These nanoplatforms displayed a consistent size distribution, an average diameter of 100 ± 10 nm, and consistent morphological features. Furthermore, TeNDs exhibit a strong photothermal response and produce reactive oxygen species (ROS) when subjected to near-infrared (NIR) radiation. Moreover, ZIF-8 has shown a significant loading capacity for the medication doxorubicin hydrochloride (DOX), and subsequent drug release is controlled by pH and NIR, both responding to stimuli. Notably, this nanosystem has demonstrated excellent performance within *in vitro* assay by reducing the challenges associated with conventional anticancer therapies while enhancing their therapeutic abilities, auguring auspicious prospects for translation into *in vivo* applications, thereby highlighting its potential as a pioneering therapeutic modality.



KEYWORDS: *TeNDs, ZIF-8, photothermal therapy, photodynamic therapy, chemotherapy*

INTRODUCTION

Cancer has gravely threatened global public health for decades due to insufficient awareness concerning early clinical diagnosis, proficient cancer screening technologies, and effective treatments. Consequently, cancer inadvertently increases to an advanced stage, leading to a rise in mortality among cancer patients.[1] Researchers from various fields, such as material science, biology, and medicine, have collaborated to create pioneering methodologies for identifying and treating incipient malignant tissue.

In contemporary medical practice, prominent cancer treatment modalities encompass chemotherapy,[2] radiotherapy,[3,4] and high-intensity focused ultrasound therapy.[5] These approaches have yielded promising results, by inhibiting the spread of tumor cells and extending patient survival. Furthermore, prior research has provided evidence supporting the effectiveness of photodynamic therapy (PDT) in managing gastric cancer and nonsmall cell lung cancer.[6,7] Besides, initial clinical research has proved the robust anticancer potential of modalities, for instance, photothermal therapy (PTT),[8,9] immunotherapeutic approaches,[10] and gene-based therapy.[11]

Various approaches to cancer treatment have been extensively employed, encompassing surgery, radiation therapy, immunotherapy, and hyperthermia treatment. Nonetheless, when used as single treatments, they each present notable disadvantages, ranging from undesirable side effects such as nausea and vomiting in the case of chemotherapy to treatment-related anxiety and general damage to healthy cells.[12,13] Consequently, to overcome the innate constraints of individual treatments and better satisfy the growing need for effective interventions, the current development in cancer therapy focuses on creating multifunctional nanoplatforms that synergistically combine distinct therapeutic modalities to combat diseases.[14−16]

Formerly, photothermal therapy (PTT) emerged as an exceptionally auspicious approach to mitigate the side effects of traditional cancer treatments. PTT relies on the utilization of ablation agents, often in the form of nanomaterials with inherent photothermal properties, to transform light energy into heat. This mechanism facilitates the destruction of targeted cancer cells through elevated temperatures while preventing normal cells from pronounced damaging consequences. This concept rests on the premise that normal cells

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