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Mesoporous silica nanoparticles: Controlled synthesis and biomedical applications

Jianlin Shi
Shanghai Institute of Ceramics - CAS, China

Drug Delivery Systems (DDSs) are expected to overcome most of the drawbacks of traditional cancer thermotherapy by administrating free anticancer drugs. Mesoporous Silica Nanoparticles (MSNs) have been found to be capable of efficiently delivering anticancer drugs with sustained and controllable drug release features and possible targeting effects, and have now become one of the most attractive research focuses. Monodisperse MSNs have been synthesized in controlled manners with tunable pore and particle sizes and compositions. A structure difference-based selective etching strategy has been developed to synthesize hollow-structured MSNs (HMSNs) with excellent monodispersity for enhanced drug loading and/or different kinds of anticancer drugs. The MSNs-DDSs or HMSNs-DDSs have been demonstrated to be effective in the deliveries and controlled releases of drugs, genes, or the co-delivery of drugs and genes, for the enhancement of therapeutic efficacy, multi-drug resistance overcoming and anti-metastasis of cancer cells. Especially, nuclear-targeted and vascular-cellular-nuclear sequential targeted drug delivery can be achieved by MSNs-DDSs under certain conditions. Also, drug release from MSNs-DDSs can be controlled by various strategies. The multi-functionalization of MSNs enables the developments of various theranostic nanomedicines for combined tumor diagnosis and therapy, or even multimodal therapies. Most recently, we have attempted to use non-toxic nanomaterials/molecules for tumor chemotherapy, which is based on the fact that these non-toxic matters will become intra-tumorally toxic or harmful, or induce toxic or harmful effects in response to tumor microenvironment (TME), such as mild acidity and/or reducibility, thus maximally mitigating the side-effects of chemotherapy.

jlshi@mial.sic.ac.cn