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Editorial

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Preface to Forum on Materials for Theranostics

This issue of *ACS Applied Materials & Interfaces* features a Forum focused on materials for theranostics. Theranostics is a word that combines diagnostics with therapeutics and may be defined as the association of a diagnostic test with a therapy. More broadly speaking, the theranostic field covers in vitro diagnosis, in vivo molecular imaging, and therapy with new tools. Nowadays, theranostics is not confined to the biomedical community. In fact, we have witnessed rapid advances in the field of materials research in this direction, especially with the emergence of nanotechnology in past decade. As examples, biosensors with nanostructured surfaces and/or nanoparticle-mediated signal amplification have remarkably increased the sensitivity for detecting a wide range of biomarkers for cancers and other important diseases. Designed multifunctional nanoprobes can readily enter cells, targeting specific organelles and emitting strong fluorescent or magnetic signals. Also, rational engineering of delivery materials holds great promise to greatly improve the efficacy and specificity of cancer therapy. As an attempt to reflect important progress and provide a broader perspective in this exciting field, we organized this Forum by inviting active theranostic researchers to contribute a collection of research articles and reviews.

In this issue, Zhong and co-workers presented an excellent review summarizing recent advances in designing functional nanomaterials for theranostic applications. They especially emphasized the significance of understanding nanoparticle-biomolecule interactions, which form the basis for bottom-up design of theranostic materials. Unsurprisingly, inorganic nanomaterials have become popular choices given their attractive optical and electronic properties. Two groups explored the potential of gold nanoparticles (AuNPs) for immunological assays and drug delivery. Wang and co-workers synthesized a new type of flowerlike gold nanostructure with strong surface-enhanced Raman scattering (SERS) properties, which greatly improve the sensitivity for protein detection. Huang and co-workers unctionalized AuNPs with aptamers for targeted, photoresponsive drug delivery. Several groups employed a type of ultrathin two-dimensional nanomaterials, graphene oxide (GO), as theranostic materials. Li and co-workers developed a generic strategy for RNA aptamer sensors by regulating their adsorption on GO. Huang and co-workers found that functional GO could be coupled with laser desorption/ionization mass spectrometry to sensitively detect microRNAs, which have proven to be very promising biomarkers for many important diseases. Liz-Marzan combined the advantages of both AuNPs and GO to develop a SERS-active nanocomposite with promising drug delivery properties. Different from these inorganic nanoparticle-based studies, polymers possess many useful properties for theranostic applications, as summarized in a review by Luk and Zhang. Along this direction, Cai, Gong, and co-workers designed multifunctional unimolecular micelles by using brush-shaped amphiphilic block copolymers, which synergistically integrated several attractive theranostic properties including tumor targeting, controlled release and positron emission tomography imaging capabilities. He and co-workers exploited interesting properties of regenerated silk fibroin films to fabricate controllable nanostructures for drug delivery. In addition to these inorganic and organic materials, biomolecules by themselves are attractive theranostic materials. Yu and co-workers developed a versatile scanometric detection platform for point-of-care tests by using DNA molecular beacons. Tymoczko, Schuhmann, and Gebala interrogated interfacial effects on DNA hybridization detection under external electrical potential. Xie and Leong employed self-assembled, pyramid-like DNA tetrahedral nanostructures as scaffold for the integration of detection and killing of bacteria.

From the concise collection in this Forum, we have seen many excitingly new studies in the theranostic field. Despite the rapid progress, we have also seen that the gap from bench to bedside remains largely from a translational point of view. There is much to be explored in both fundamental and practical aspects to bridge such a translational gap. In terms of applications, it is particularly important for materials scientists to interact closely with clinicians to have a better understanding of requirements in clinical settings. Likewise, it is indispensable to challenge new tools developed by materials scientists with clinical samples.

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Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.

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