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Preface

Developments in nanoscience and nanotechnology have already had a far-reaching impact in traditional analytical chemistry, opening a new era in analytical methodology and instrumentation. Scanning probe microscopes (SPM) are not just fancy toys for physicists and physical chemists, but have become ordinary instruments for high-resolution surface analysis. In fact, many universities have included SPM in their undergraduate analytical courses. Meanwhile, research on microfluidic chips has opened up a new way to perform chemical and biological separation and sampling. More exciting progress continues: the interface of nano-research and biological sciences has spawned a new research field—nanomaterial-based sensing. The new nano-sensors allow biological assays with a higher sensitivity and throughput than those for conventional analytical methods.

Nano-sensors have been extensively studied in both in vitro and in vivo assays. In vitro nano-sensors are now coming of age. Some point-of-care devices for rapid diagnosis of pathogenic and genetic diseases (e.g., HIV), like today's blood glucose kits, will come to market in the very near future. In contrast, it will take a much longer time to use in vivo nano-sensors in clinical trials, in part, because of the toxicity of nanomaterials. The detailed mechanisms for the in vivo toxicity of nanomaterials remain unclear. Recently, a few researchers have launched systematic studies on nanomaterial toxicity on the level of a cell, a tissue, or an organ of animal subjects. These studies will help to design better in vivo nano-sensors. In addition, the problem of non-specific binding between nano-probes and their targets has not been totally solved for both in vitro and in vivo nano-sensors. This problem can block the way for using nano-sensors in ultra-high-sensitivity detection systems.

In general, such non-specific binding originates from surface chemistry issues of nanomaterials. Surface engineering of nanomaterials (i.e., design of nanomaterials with special surface functionalization) holds the key to eliminating non-specific binding, increasing target selectivity and even decreasing toxicity of nano-probes. However, we do not totally understand the fundamental principles governing surface properties of nanomaterials, because we only hold some small pieces of this huge puzzle. Nanomaterial surface engineering will take us a great deal of effort and perhaps also a great deal of time; and it will be a major research topic in our field over the next decade.

This special issue of *Talanta* presents readers with current exciting developments in analytical chemistry as influenced by nanoscience and nanotechnology. It includes pieces on analytical scanning probe microscopy, and chemical and biological sensing with inorganic and organic nano-probes.

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