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In-vitro Metabolic Fingerprinting Using Plasmonic Chips by Laser Desorption/Ionization Mass Spectrometry

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Abstract : The metabolic analysis is more distal over proteomics and genomics engaging in clinics and needs rationally distinct techniques, designed materials, and device for clinical diagnosis. Conventional techniques such as spectroscopic techniques, biochemical analyzers, and electrochemical have been used for metabolic diagnosis. Currently, there are four major challenges including (I) long-term process in sample pretreatment; (II) difficulties in direct metabolic analysis of biosamples due to complexity (III) low molecular weight metabolite detection with accuracy and (IV) construction of diagnostic tools by materials and device-based platforms for real case application in biomedical applications. Development of chips with nanomaterial is promising to address these critical issues. Mass spectroscopy (MS) has displayed high sensitivity and accuracy, throughput, reproducibility, and resolution for molecular analysis. Particularly laser desorption/ ionization mass spectrometry (LDI MS) combined with devices affords desirable speed for mass measurement in seconds and high sensitivity with low cost towards large scale uses. We developed a plasmonic chip for clinical metabolic fingerprinting as a hot carrier in LDI MS by series of chips with gold nanoshells on the surface through controlled particle synthesis, dip-coating, and gold sputtering for mass production. We integrated the optimized chip with microarrays for laboratory automation and nanoscaled experiments, which afforded direct high-performance metabolic fingerprinting by LDI MS using 500 nL of serum, urine, cerebrospinal fluids (CSF) and exosomes. Further, we demonstrated on-chip direct in-vitro metabolic diagnosis of early-stage lung cancer patients using serum and exosomes without any pretreatment or purifications. To our best knowledge, this work initiates a bionanotechnology based platform for advanced metabolic analysis toward large-scale diagnostic use.

Keywords : plasmonic chip, metabolic fingerprinting, LDI MS, in-vitro diagnostics
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