A New Optical Method for Characterizing Nanoparticles

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- Biomedical Engineering
- Pharmaceuticals

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- Biomedical Science
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- Nanophotonics
- Pharmaceutical Engineering

Nanomedicine and nanotechnology are rapidly advancing with various potential applications in medicine and biology, including the development of mRNA vaccines using lipid nanoparticle delivery methods. Over the past decade, the US FDA has approved more than 100 nanomedicines for commercial use, indicating the significant impact of these technologies on daily life. In characterizing new nanomedicines, it is crucial to understand NP-cell interactions and test their effectiveness. However, the common technique of fluorescent labeling has several limitations, including photobleaching, altered properties, and difficulty distinguishing individual particles from groups. This can impede continuous observations and measurements of nanoparticles. Therefore, there is a need for methods to identify nanoparticles without the use of fluorescent labeling.

Researchers at Purdue University have developed a technology that employs hyperspectral imaging and analysis (HSIA) and interferometry to characterize the features of nanoparticles and identify chemically similar groups of nanoparticles, including those with a radius ranging from 5-1000 nm. This system is highly effective in measuring diû usivity, size, mass, and particle-cell association. One of the major benefits of the HSIA system is its label-free nature, which eliminates the need for fluorescent or other labels and allows for more direct analysis of the intrinsic properties of NPs. This innovation has the potential to replace fluorescent labeling in specific particle identification, thereby advancing research on particle characterization and cell-particle interactions.

Technology Validation: Nanometer-level spatial resolution can detect spectral features of individual particles using a super-continuum laser and interferometric point-spread functions.

Effective comparison of the instantaneous spectral profile to the previously acquired hyperspectral library information to identify nanoparticles in dynamic and flowing samples, which demonstrates the system's capacity for label-free super-resolution tracking and identification of nanoparticles.

Advantages:
-Provides ultra-high spatial resolution, such as being able to detect particles down to a few nanometers, including individual proteins
-Distinguishes spectral differences in particles that have similar intensities
-Does not alter the intrinsic properties of the nanoparticles

Applications:
-Bio-nanoparticle label-free super-resolution tracking and identification
-Cytometric quantification and identification
-Nano-PIV in biological environments

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