Docket #: S19-246

Surface-Enhanced Raman Scattering Nanoparticles for Imaging Tumor Oxidative Stress

Researchers at Stanford have developed reactive oxygen species (ROS) sensing nanoparticles (NP) that can amplify Raman fingerprint signals and detect ROS changes. Using Raman spectrometry augmented with nanoparticles that leverage Surface Enhanced Raman Scattering (SERS), the researchers detect ROS at femtomolar levels in cell models and a mouse xenograft model. The mesoporous SiO2 shell containing gold nanoparticle core with a Raman layer, targets cancer cells via an integrin-targeting cystine knot peptide. These SERS NPs provide a powerful and sensitive tool for the detection of ROS, and the diagnosis and treatment of conditions associated with oxidative stress including cancer, inflammatory, and neurodegenerative diseases. Furthermore, the SERS NPs have multimodal imaging properties and can be tailored to serve as a contrast agent for CT and optoacoustic imaging, as well as PET imaging.

Stage of Development: Research In Vivo

SERS nanoparticles detected oxidative stress in variety of cancer cell lines, and were consistent with alternative assays for ROS like DCFH-DA. In a mouse model, the inventors demonstrated that SERS nanoparticles administered via IV localize to tumors with high ROS levels and are detectable in whole animal imaging, with no signal detected in healthy tissue.

Applications

- **Cancer Diagnostics, Monitoring, and Treatment (Theranostics) across Multiple Imaging Platforms:**

    - Real-time measurement of reactive oxygen species (ROS) and oxidative stress within tumors
    - Non-invasive tumor detection
    - Tumor monitoring and treatment
- **Drug Development and Screening:**
    - Screening compounds that modulate oxidative stress
    - Validating targeted cancer therapies
    - Monitoring drug delivery and efficacy in preclinical models
- **Precision Medicine:**
    - Patient-specific, real time assessment and monitoring of oxidative stress levels in diseased tissue
    - Personalized treatment based on ROS measurements
- **Inflammatory Disease Management:**
    - Tracking oxidative stress in chronic inflammatory conditions and assessing anti-inflammatory treatment efficacy
    - Monitoring autoimmune disease progression
- **Neurodegenerative Disease Research:**
    - Early detection of disease-associated oxidative damage
    - Studying oxidative stress in Alzheimer's, Parkinson's, and other neurodegenerative conditions

Advantages

- Higher sensitivity than fluorescent ROS markers
- No photobleaching, unlike fluorescent markers
- Versatile across diagnostic types (PET, CT, optoacoustic imaging)
- Broad use across cancer types

Publications

- Razavi, M., Ren, G., Wang, J., Kimura, R., & Thakor, A. S. (2019). Imaging Tumor Oxidative Stress with Surface Enhanced Raman Scattering Gold Nanoparticles. *Journal of Biomedical Nanotechnology, 15*(10), 2130-2141. https://doi.org/10.1166/jbn.2019.2819

Patents

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