Washington University in St. Louis
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NANOTHERMOMETERS FOR CELLULAR-LEVEL TEMPERATURE MONITORING IN ABLATION THERAPY OR RESEARCH

Berezin, Mikhail, Gustafson, Tiffany

Weilbaecher, Craig

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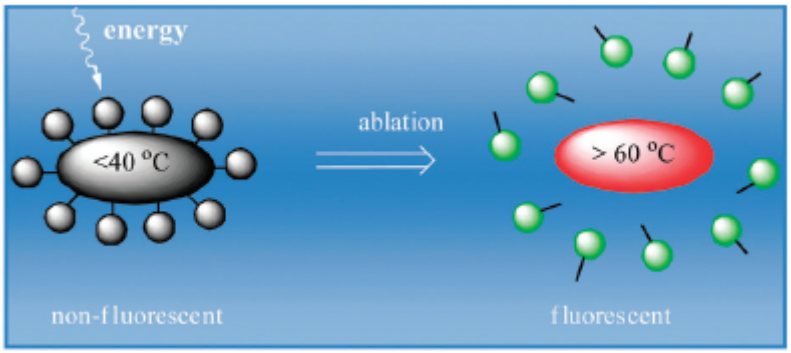
Technology Description

Researchers in Prof. Mikhail Berezin's laboratory have developed patented, fast-acting, gold nanoparticle-based optical "nanothermometers" that can detect temperature changes at the cellular level by emitting a fluorescent signal. These molecules were designed to enable precise monitoring of thermal treatment, thereby preventing the damaging effects of overheating during ablation and other therapies.

The basic structure of the nanothermometer is a gold nanoparticle core with a flexible, temperature-sensitive peptide linker-dye conjugate which is optimized to trigger fluorescence when a critical temperature is reached. For ablation, the dye could label tissues with an irreversible signal indicating the area that has been treated thereby ensuring that all the targeted tissue is treated, while preventing overheating. These nanothermometers can be tuned for different desired temperatures/applications by customizing the temperature-sensitive linker. The technology could be used to monitor ablation therapy (laser or RF) as well as for in vitro or in vivo research.



Nanothermometers respond to heat by activating a fluorescent marker that indicates the temperature based on the structure of a temperature-sensitive dye-peptide conjugate. The peptide-dye structure can be customized to a desired temperature detection range.

Stage of Research

The inventors have synthesized nanothermometer constructs and demonstrated their tunable, temperature-sensitive activity in vitro (specifically optimized for the ablation range of >70°C).

Applications

- **Cell-level temperature detection**, with end user applications in:

- **medical imaging for heat-based therapy** such as **ablation** (laser ablation or RF heating)
- **in vitro or in vivo imaging** for research

Key Advantages

- **Tunable -** temperature detection range and response time can be adjusted by customizing the linker
- **Fast fluorescence**
  - excellent response time to heating (response rate of 3.38% deg^{-1} sec^{-1})
  - >10x increase in fluorescence after a complete heating-cooling cycle
  - avoids overheating of the treatment area for thermal therapies
- **Precision for therapeutic ablation:**
  - irreversible fluorescent signal highlights treated regions to avoid repeating treatment in the same area
  - could improve patient safety and therapeutic efficacy of the procedure

Publications

- Gustafson, T. P., Cao, Q., Wang, S. T., & Berezin, M. Y. (2013). Design of irreversible optical nanothermometers for thermal ablations. *Chemical Communications*, 49(7), 680-682

Patents

- Nanothermometer, methods and uses therefor (U.S. Patent No. 9,274,008)

Website

- Berezin Lab