Gold Nanoparticle-Based Sensors Activated by External Radio Frequency Fields

A novel molecular beacon (a nanomachine) is constructed that can be actuated by a radio frequency (RF) field. The nanomachine consists of the following elements arranged in molecular beacon configuration: a gold nanoparticle that acts both as quencher for fluorescence and a localized heat source; one reporter fluorochrome, and; a piece of DNA as a hinge and recognition sequence. When the nanomachines are irradiated with a 3 GHz RF field the fluorescence signal increases due to melting of the stem of the molecular beacon. A control experiment, performed using molecular beacons synthesized by substituting the gold nanoparticle by an organic quencher, shows no increase in fluorescence signal when exposed to the RF field. It may therefore be concluded that the increased fluorescence for the gold nanoparticle-conjugated nanomachines is not due to bulk heating of the solution, but is caused by the presence of the gold nanoparticles and their interaction with the RF field; however, existing models for heating of gold nanoparticles in a RF field are unable to explain the experimental results. Due to the biocompatibility of the construct and RF treatment, the nanomachines may possibly be used inside living cells.

In a separate experiment a substantial increase in the dielectric losses can be detected in a RF waveguide setup coupled to a microfluidic channel when gold nanoparticles are added to a low RF loss liquid. This work sheds some light on RF heating of gold nanoparticles, which is a subject of significant controversy in the literature.