Comparative study on photothermal conversion performance of gold nanorods and indocyanine green

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Background

Photothermal conversion performance plays an important role in photoacoustic imaging, photothermal therapy and thermo-induced release in drug delivery systems. Both of gold nanorods (AuNR) and Indocyanine green (ICG) are well known for their capacity to conversion of near-infrared (NIR) light to heat. However, it has been reported that laser irradiation causes the structural and spectral changes of AuNR. Meanwhile, ICG also suffers from severe photothermal bleaching. Thus, a thorough understanding of their photothermal conversion performance in various experimental parameters will help to promote their biomedical applications.

Methods

Here, an AuNR suspension with a maximum peak of about 780 nm was synthesized, corresponding to ICG with same initial absorption intensity. A multimode fiber coupled laser operating in a continuous-wave (CW) mode and a Vevo LAZR PA system with a nanosecond pulsed laser were used as the light source, respectively. Then, the photothermal conversion performance was investigated by UV-Vis absorption spectroscopy, solution temperature detection and photoacoustic signal detection, respectively.

Results

Under CW laser irradiation, both of AuNR and ICG with same absorption intensity at the initial stage, showed a significant temperature rise in the first irradiation cycle. However, the photothermal conversion performance of ICG was greatly attenuated in the second irradiation cycle, but had little effect on AuNR (Fig. 1A). It should be noted that the performance of AuNR was very unstable if there was no enough CTAB in the solution, leading to aggregation and losing its unique optical properties (Fig. 1B). Under pulsed laser irradiation, we were surprised to find that the photoacoustic signal of ICG was much stronger and more stable than AuNR in aqueous solution (Fig. 1C). Since a nanosecond pulsed laser has much higher power than a CW laser, it will convert the rod structures into spheres. However, when we dispersed AuNR in ethylene glycol solution, a significant photoacoustic signal was detected.

Discussion

Generally, the extinction coefficient of AuNR is much higher than that of ICG. However, their actual photothermal performance for biomedical applications also depends on experimental conditions, especially their environmental impact should not be ignored.

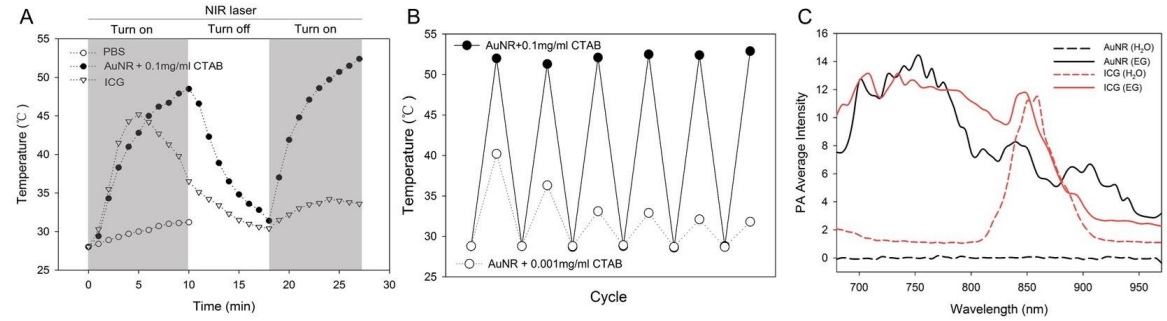

Fig. 1. The photothermal conversion performance of AuNR and ICG in various experimental parameters. A. Experimental temperature traces of AuNR, ICG and PBS under CW laser irradiation. B. The influence of CTAB concentration on the photothermal conversion performance of AuNR. C. The photoacoustic signal of AuNR and ICG in different solutions under pulsed laser irradiation.