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Stable chemical forms of stored gold nanorods in tissues

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Introduction

As a promising nanomaterial in biomedicine, it is quite urgent to evaluate potential biological effects and safety of gold nanorods (Au NRs) before their applications. Some Au (I) compounds can induce cell apoptosis either by direct coordination with thioredoxin reductase in mitochondrion or by damaging the mitochondrial membrane. However, it is uncertain about the chemical fates of Au NRs after their uptake and accumulation in cells and tissues, which partly determines their negative effects *in vivo*. As a possible coordinated element, the chemical form of sulfur may be also essential to affect the interaction at the nano-biological interface. Structural analysis of gold and sulfur is significant for us to understand the chemical forms of internalized and stored of Au NRs *in vivo* at the atomic level. It can also provide some structural and functional information to help us to understand the interaction between the metal nanomaterials and biological systems.

In this work, inductively coupled plasma mass spectrometry (ICP-MS) was used to analyze tissue distribution of Au NRs at different intervals after the injection of nanomaterials. Then, synchrotron-radiation XANES was employed to study the transformation and structural features of gold for Au NRs in accumulated tissues [1].

Experiments

The seed-mediated growth method was used to synthesize Au NRs (58 nm *15 nm). Au NRs in saline were intravenously injected into Sprague-Dawley rats at a dose of 560 μg/kg weight. At different time intervals, rats were sacrificed and several organs were collected to measure the gold content by ICP-MS. High accumulated tissues were lyophilized, ground, pressed into pellets. Then, they were employed for XANES studies about gold and sulfur at BL-12C and BL-11B at PF, KEK, Tsukuba, Japan.

Results and Discussions

ICP-MS results showed that liver is the main target organ for Au NRs, with about 60% injected Au NRs one day post injection. Sulfur K-edge XAFS results of liver samples shows that its speciation does not change during long term accumulation of Au NRs *in vivo*. Moreover, the oxidation state of gold in the liver and spleen samples maintained as zero valence rather than ionic forms. Therefore, Au NRs are still inert and they will not undergo obvious oxidation during their storages in tissues within at least 7 days. It also suggests that Au NRs are safe to be used in consideration of the possibility to be oxidized, dissolved or ionized *in vivo*.

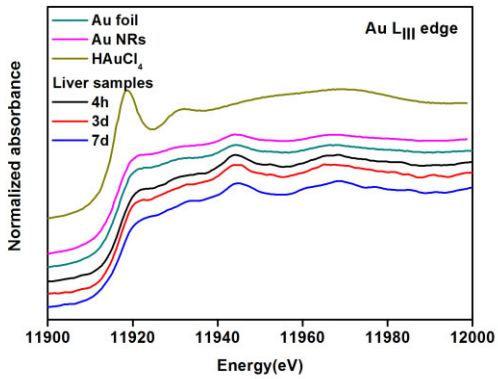

Fig.1 Au L-$_{III}$ edge absorption spectroscopy for reference and liver samples.

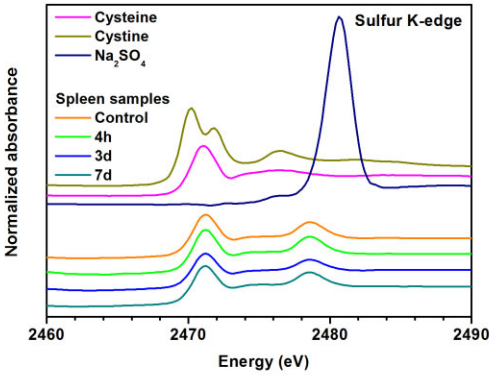

Fig.2 Sulfur K-edge absorption spectroscopy for reference and liver samples.

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References

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