Development of complex boron compounds for treatment and absorbed dose evaluation during BNCT

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In BNCT, release of alpha-particles inside tumor cells makes direct measurement of the absorbed dose difficult. Activation of golden foils placed close to the irradiated samples leads to accumulation of ^{198}Au isotope with a half-life of 2.7 days. Further measurement of gold-released 411 keV gamma-rays provides data for absorbed dose calculations. However, for human BNCT applications, even more precision is required. Therefore, we proposed using boron and a high-Z element, such as gold, for treatment and *in situ* boron dose evaluation during BNCT. Our previous studies on neutron irradiation of gold nanoparticles combined with boron compounds proved the efficacy of the method.

From multiple options of nanoparticle synthesis, we moved towards elemental boron nanoparticles (99.99% boron) as core components. For boron nanoparticle synthesis we proposed cascade ultrasonic dispersion / destruction of elemental boron microparticles (10-20 μm) in an aqueous medium. As the final form of the boron compound is an aqueous particle dispersion, using water as the dispersion medium is one of our main advantages over traditional powder-based methods of nanoparticle synthesis. In boron core particle production, ultrasonic dispersion degrades large boron crystallites and forms nanoscale particles less than 100 nm in diameter. Combination with gold provides both biocompatibility and options for a wide range of bonding with tumor-targeting molecules.

The synthesis of nanoparticles is usually monitored by dynamic light scattering, transmission electron microscopy (TEM), and X-ray crystallography. As boron does not absorb electrons as effectively as gold, initial TEM analysis of core boron nanoparticles was challenging. Cytotoxicity tests defined boron concentrations in ranges eligible for biological irradiation experiments. The study is ongoing, and a more detailed description will be provided at the conference.