title: Neutron Target Research and Development for BNCT --Direct observation of proton induced blistering using light-polarization and -reflectivity changes--

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Abstract: An accelerator-based BNCT (Boron Neutron Capture Therapy) facility is being built at the Ibaraki Neutron Medical Research Center. It consists of a proton linac (8 MeV, 10mA average; 80kW), a beryllium target, and a moderator system to provide an epi-thermal neutron flux for patient treatment. The latest design of the target and moderator system shows that a flux of 4.6×10^9 epi-thermal neutrons / cm2 / sec can be obtained. This is three times the flux from the existing nuclear reactor based BNCT facility at JAEA (JRR-4). The technology choices for this BNCT were driven by the need to site the facility in a hospital where low residual radioactivity is essential. The maximum neutron energy produced from an 8-MeV proton is 6 MeV, which is below the threshold energy of the main nuclear reactions that produce radioactive products. Simulations show that a very low radiation environment can be realized by using an 8-MeV proton beam. The downside of this technology choice is that the proton density must be very high and consequently blistering becomes a problem. When a proton beam irradiates a metal, the protons stopped inside capture free electrons in the metal to form a hydrogen gas. Eventually, blisters and/or flakes appear on the surface as the pressure of the hydrogen gas rises enough to cause ruptures. A polarized long distance microscope (PLDM) was chosen to be able to obtain images with high-sensitivity and high-spatial-resolution in real time while under the irradiation of a proton or H- beam on the test materials. Surface roughness due to the formation of blisters was detected by the change of reflectivity using a glancing incidence He-Ne laser beam. Hydrogen formation was also confirmed by detecting a sharp rise in the hydrogen partial gas pressure coincident with the blistering. The first results from this equipment on the in-situ formation of blisters on the surface of pure copper are presented. The copper sample was irradiated by a 750keV, 25μA H- beam up to the fluence about 1.8 x 10^22 m^-2.