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Development of a compact accelerator-based pulsed neutron source and simulation of the neutron beam performance and Bragg edge imaging

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We have been developing a compact accelerator-based pulsed neutron source at the National Institute of Advanced Industrial Science and Technology (AIST) in Tsukuba, Japan. The main purpose of this neutron source is to analyze structural materials of automobiles and other transportation vehicles nondestructively by means of the high penetration power of neutron beams. We plan to focus on Bragg edge imaging because it can provide images of crystalline strain, phase, size, orientation etc. which will be useful for the development of innovative materials and their joining techniques. The key parameters required for using Bragg edge imaging effectively are the neutron flux and wavelength resolution at a sample position. In order to optimize the flux and resolution to the highest values possible for a compact neutron source, we designed a dedicated accelerator, neutron source, and beam line. The flight path length of the neutron beam is 8 m. A solid methane decoupled neutron moderator was chosen. A linear electron accelerator was adopted and the pulse width of the electron beam is less than 10 microseconds. These choices make possible a neutron wavelength resolution of about 0.6 %. To obtain a high neutron flux, the repetition rate of the electron accelerator is 100 Hz and the maximum power of the electron beam is about 10 kW. We are performing Monte-Carlo simulations to estimate the performance of the neutron beam for these parameters. The simulations suggest a neutron flux of about 11,000 1/cm2/s for thermal neutrons and a neutron wavelength resolution of about 0.6 % at the sample position is possible. In this presentation, we will introduce the compact accelerator-based pulsed neutron source at AIST, which is now under construction, and our estimates of the neutron beam performance and Bragg edge imaging examples obtained by Monte-Carlo simulations.
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