# Investigation of the imaging characterization of polycrystalline scintillation screens with high spatial resolution for neutron radiography

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Digital radiography has become an essential tool in industrial non-destructive testing (NDT), utilizing both X-rays and thermal neutrons. Historically, X-ray radiography has dominated NDT applications; however, neutron radiography is increasingly recognized for its unique elemental sensitivity, enabling the visualization of materials that are difficult to detect with X-rays alone. For instance, Neutrons exhibit high penetration through metals while interacting strongly with hydrogen and lithium; therefore, neutron radiography is particularly effective for visualizing fuel cells and lithium-ion batteries.

Thick ZnS:Ag/LiF-based scintillating screens exhibit low gamma-ray sensitivity, high scintillation efficiency, and limited spatial resolution characteristics in current system, which render them suitable for neutron radiography. Currently, among various scintillator materials, Gd-based scintillator screens are being actively investigated to further enhance the spatial resolution of neutron imaging to several tens of micrometer scale. In this study, Two polycrystalline $Gd_2O_2S$:Tb and $Gd_3Al_2Ga_3O_{12}$:Ce scintillating screen types, which were commercial products for X-ray imaging with different active layer thicknesses were adopted in the experiment, and ZnS:Ag/LiF with several hundred micrometer thickness was also used for comparison.

Two type polycrystalline screens with different thicknesses, a mirror and optical lens-coupled CCD camera (model: Andor DW936N-BV) were used for neutron imaging characterization. Thermal neutron flux with $1x10^9 n/cm^2$-s was used at the Ex-core neutron irradiation facility (ENF) in HANARO for neutron radiography. The detection characteristics and imaging performance such as the emission spectrum of used scintillators, linearity, signal-to-noise ratio and the spatial resolution with a resolution test target under different neutron irradiation system conditions were investigated (Figure 1). The results indicate that new neutron scintillators can be a powerful candidate for providing an increased spatial-resolution of a few tens of microns in precision neutron radiography and tomography applications.

Figure 1. Picture of ENF experimental setup (left), Gd-based scintillating screens (center) and X-ray and neutron slice images with a cylindrical lithium-ion battery (right).

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