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NIPS-NORMA: a new neutron-based element-mapping and imaging facility at the Budapest Research Reactor

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Numerous non-destructive techniques utilize neutron attenuation, scattering or capture to gain morphological, structural or elemental information about the material under study. However, few attempts have been made so far to use neutron-induced gamma radiation for 3D element imaging. A novel non-destructive method is being developed to determine the distribution of major elements and visualize internal arrangement of heterogeneous objects, by combining position-sensitive prompt-gamma activation analysis (PGAI) and neutron radiography/tomography (NR/NT).

Though conventional PGAA provides limited or no spatial resolution, a strong collimation of the neutron beam and the gamma-detection reduces the sampling volume, i.e. the origin of the detected gammas is localized. This provides the basis to construct the element distribution of the sample by systematic scanning, i.e. measuring a set of gamma spectra at different positions. This technique is called Prompt Gamma Activation Imaging (PGAI). While PGAI gives a 3D distribution of the elements, NR/NT produces high-resolution 2D/3D images to survey the structure of the object. The two datasets can be merged into a common coordinate system for a sound chemical and structural interpretation.

It is often sufficient to measure the elemental compositions only at selected spots of the object and link them with the structure revealed by NR/NT. This makes the technique, called tomography/radiography-driven PGAI, much more feasible and cost-effective.

The first ever facility using direct element mapping in combination with neutron imaging was constructed at the Budapest Research Reactor in 2007. Recently a permanent facility, called NORMA, was commissioned. The setup consists of a variable neutron collimator, sample chamber, neutron tomograph, xyzw sample stage, gamma collimator, a Compton-suppressed and well shielded high-purity germanium gamma-ray (HPGe) detector and acquisition software.

The facility is open to the scientific community via EU-funded access programs related to the Budapest Neutron Center in the fields of industrial, cultural heritage, nuclear data and material science applications. Results of this non-destructive technique will be presented here from various fields of applications.

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