Application of neutron-based analytical and imaging techniques in electronic waste characterization

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Nowadays, the presence of electronic waste (e-waste) poses a serious environmental problem. To develop economical, safe, and environmentally friendly recycling technologies for e-waste, comprehensive information is required on their elemental composition, internal structure, and spatial location of each element; therefore, the development of methods for e-waste characterization is a topical issue. In our research, we successfully applied neutron-based analytical techniques available at the Budapest Neutron Centre, such as instrumental neutron activation analysis (INAA) and prompt gamma activation analysis (PGAA), to determine the quantitative elemental composition of multiple common e-waste types, including printed circuit boards and light-emitting diodes. Since these techniques enable the direct measurement of solid samples, they offer a more reliable option for the comprehensive determination of the elemental composition of e-waste than the conventionally used ICP-MS and ICP-OES methods, which require sample dissolution and may therefore be subject of bias if losses occur for individual elements during digestion. We identified and successfully corrected matrix effects associated with the analysis of e-waste using neutron-based methods; therefore, these techniques are more reliable than conventionally used non-destructive methods, such as XRF, which are typically strongly influenced by matrix effects. The methodology we have developed could even serve as a reference for these techniques. In another aspect of our research, we successfully used the combination of neutron- and X-ray-based imaging to determine the internal structure of complex, intact e-waste items. Furthermore, we successfully applied the PGAA in combination with imaging methods to determine the location of circular economy-relevant elements within e-waste items, which results can facilitate the selective recovery of these elements from e-waste, thereby enabling their more efficient recycling.

Short bio:

Noémi Anna Buczkó is a researcher at the Budapest Neutron Center (BNC), where, as part of her doctoral research, she investigated the applicability of

neutron-based analytical and imaging techniques available at the BNC for the characterization of e-waste items. After completing her Ph.D., she is continuing her research as part of a CERIC grant. During this project, her goal is to supplement neutron-based techniques with the technology available at CERIC partner facilities and to use the results obtained from large-scale instruments to calibrate simpler, more affordable, and even industrially applicable techniques for the characterization of e-waste.