Contribution ID: **103** Type: **Poster**

Analysis of certified reference alloys using PGAA and in-beam NAA methods

Friday, 9 December 2022 15:30 (1h 30m)

Neutron-based analytical techniques (such as prompt gamma activation analysis and neutron activation analysis) are preferred in the non-destructive bulk analysis of archaeological objects, modern alloys with protective layer, and in case of materials containing elements that are insoluble for destructive quantitative analysis. Both nuclear analytical techniques are primary methods of measurement playing an important role in analytical chemistry. Reference alloys were analyzed with PGAA and NAA in the BNC, and further PGAA and in-beam NAA experiments were carried out on them at MLZ. The combination of PGAA and in-beam NAA was the most effective to determine the alloy components, their results were in good agreement with the reference values. As, Sb and Mn had the best detection limits (tens of ppm) with in-beam NAA. Zn was detectable in ppm level only with NAA. The detection limit of Pb, an important component of bronzes is 1.7-3.0 mass percent in the presence of the dominant copper. An emerging technique, fast neutron PGAA based on the inelastic neutron scattering offers higher sensitivities for several elements of interest, than cold-neutron PGAA, as the cross sections for the fast neutron reactions are similar for every element (0.1-10 barn). This makes possible the analysis of materials containing heavy elements (like Pb) even when thick samples are used. We plan to continue the analyses of reference materials using fast neutron PGAA at the FaNGaS facility at the MLZ.

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Session Classification: Poster Session

Track Classification: Neutron Methods