

## Characterization of historical tin materials from the perspective of tin pest

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The so-called tin pest is a phase transformation of white tin ( $\beta$ (Sn)) into grey tin ( $\alpha$ (Sn)), where the disintegration of tin materials occurs due to different thermodynamic stability of the phases with a transition at 13.2 °C. In addition to temperature, another important factor influencing pest is the presence of impurities and alloying elements that can accelerate (Zn, Cu), retard (Pb, Au), or block (Bi, Sb) the degradation process. Experiments to date describe the influence of mostly one element present in the tin matrix or tin material used in industry. Historical materials often had not only different production technology but also imperfectly processed starting materials. Therefore, we first characterized real historical objects such as organ pipes, utensils and decorative objects using optical microscopy, XRF and XRD. We then observed the progression of the tin pest in the collected samples and used the course to determine the resulting effect of the combination of elements present.

These data are of high value in conservation, where the non-destructively determined elemental composition can be used to decide which tin object is predisposed to succumb to tin pest and which is not.

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