the pure AlCP system but occur as labile Tl(III) in the AlCP/Fe(III)/Fe(II) system. Such labile Tl(III) may be sorbed on the precipitated Al (hydr)oxides and is subject to reduction and further dissolution, accounting for the lower removal efficiency for Tl(I) in the presence of Fe(III)/Fe(II).

With the combination of Tl speciation for both dissolved and solid phases, this study shed light on the oxidative removal mechanisms of Tl(I) by means of the ZVAl-based Fenton-like reaction. The comparable Tl(I)-removal efficiency between AlCP and other state-of-the-art (nano) composites provides a niche opportunity to co-benefit the hazard remediation and waste reduction/reuse. (Reported by Yu-Ting Liu, National Chung-Hsing University and Liang-Ching Hsu, NSRRC)

This report features the work of Yu-Ting Liu and her collaborators published in Chem. Eng. J. ***427****, 130846 (2022).*

TPS 44A Quick-scanning X-ray Absorption Spectroscopy

- Quick-scanning X-ray Absorption Spectroscopy
- Environmental and Earth Sciences, Materials Science, Chemistry

Reference

1. K.-Y. Chen, Y.-M. Tzou, L.-C. Hsu, J.-W. Guo, Y.-L. Cho, H.-Y. Teah, Y.-C. Hsieh, Y.-T. Liu, Chem. Eng. J. **427**, 130846 (2022).

Accumulation of Gallium in Paddy Rice

Gallium (GA) released from the semiconductor industry may accumulate in soil and eventually in rice plants. X-ray absorption spectroscopy helps elucidate the translocation of Ga in soil-rice systems.

Shan-Li Wang (National Taiwan University) and his colleagues recently elucidated gallium (Ga) speciation in soils and its accumulation in rice plants (*Oryza sativa* L.) grown in Ga-contaminated soils. Ga released from the semiconductor industry is an emerging environmental contaminant. The presence of Ga has been detected in primary staple crops, such as rice and wheat, grown in Ga-contaminated soils. Therefore, humans are at the risk of Ga exposure through staple crops. However, our understanding of the fate of Ga in soil-plant systems and the potential risk of Ga contamination of soils remains limited. To elucidate the mechanisms underlying the uptake and accumulation of Ga in rice plants, Wang's team used X-ray absorption spectroscopy (XAS) at **TLS 17C1** to explore Ga speciation in three types of soil, acidic clay (Pc), acidic sandy loam (Tn), and alkaline clay (Tk), treated with varying amounts of Ga. The roots, shoots, and grains of rice plants grown in these soils were collected at different phases of rice cultivation and analyzed to determine the corresponding Ga concentrations. The Ga concentrations of the roots of rice plants grown in Pc, Tn, and Tk soils treated with 1.0 mmol kg^{-1} Ga were, respectively, 74.1, 149.3, and 39.0 mg kg^{-1} on day 45, and 25.1, 55.6, and 24.5 mg kg^{-1} on day 100 (**Fig. 1(a)**). The Ga concentrations of the shoots were 3.8–15.9 and 2.5–23.4 mg kg^{-1} on days 45 and 100, respectively (**Fig. 1(b)**). Furthermore, the Ga concentration of the grains of rice grown in the three soils was 0.3–1.9 mg kg^{-1} (**Fig. 1(c)**). The results revealed that the highest proportion of the total Ga absorbed by rice plants was accumulated in the roots, and only a small proportion was translocated to the shoots and then to the grains. The grains of rice grown in Tn soil exhibited the highest Ga concentration and thus were selected to investigate the spatial distribution of Ga in rice grains by using laser ablation

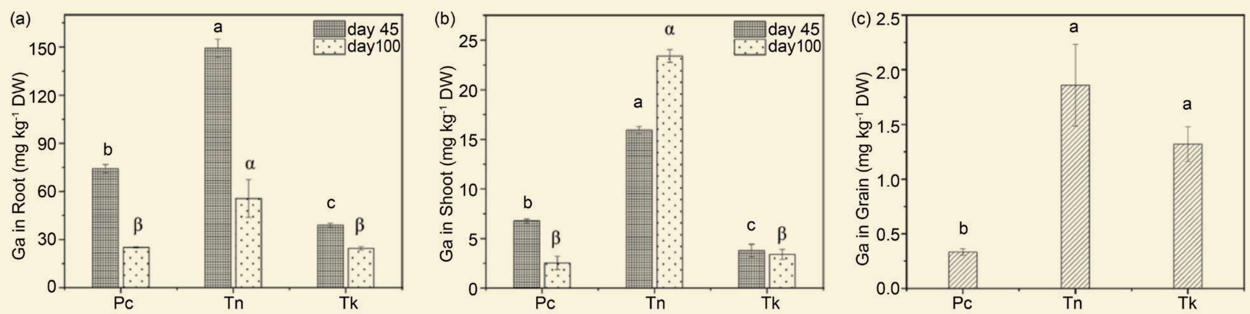

Fig. 1: Ga concentrations in the (a) roots, (b) shoots, and (c) grains of rice plants grown in three soils (Pc, Tn, and Tk) treated with a Ga concentration of 1.0 mmol kg^{-1} for 45 and 100 days. The mean values are the average of data obtained from three experimental replicates. Error bars represent the standard error of the mean values. Different letters indicate significant intragroup differences ($P < 0.05$). [Reproduced from Ref. 1]

inductively coupled plasma mass spectrometry (**Fig. 2**). Ga was distributed homogeneously in the endosperm of rice grains, which indicates a potential risk to public health through the consumption of white rice grown in Ga-contaminated soil.

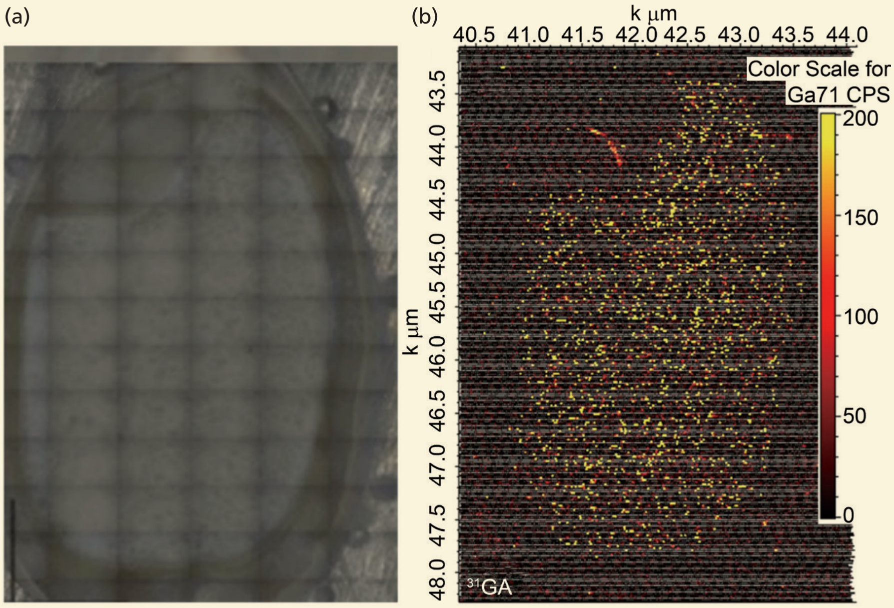

Fig. 2: (a) Visible image of a grain of rice grown in Tn soil treated with 1.0 mmol kg^{-1} Ga and (b) the corresponding spatial distribution of Ga in the rice grain observed using laser ablation inductively coupled plasma mass spectrometry. [Reproduced from Ref. 1]

The predominant Ga species in the test soils were $Ga(OH)_3$, Ga(III)–humic acid [Ga(III)–HA], and Ga(III)–ferrihydrite [Ga(III)–FH], which were identified using XAS (**Fig. 3**). On day 0 (before rice cultivation), the relative concentrations of Ga(III)–FH, $Ga(OH)_3$, and Ga(III)–HA in the soils were 39–56%, 21–38%, and 6–24%, respectively. On day 100 (after rice cultivation), the predominant Ga species in all three soils was $Ga(OH)_3$ (43–59%); the relative concentrations of Ga(III)–FH decreased in all soils. However, the relative concentrations of Ga(III)–HA decreased in Pc soil but increased in Tn and Tk soils. The decreases in the relative concentrations of Ga(III)–FH in the soils (15–30%) may be attributed to the reductive dissolution of Fe(III) hydroxides under the submerged condition of paddy soils, which contributed to Ga uptake by the roots of rice plants.

To the best of our knowledge, this study was the first to explore Ga speciation in soils using Ga K-edge XAS and to indicate the potential risk of Ga contamination of soils. The findings may help devise effective strategies for the reduction of health risks from the consumption of rice grown in Ga-contaminated soils. (Reported by Shan-Li Wang, National Taiwan University)

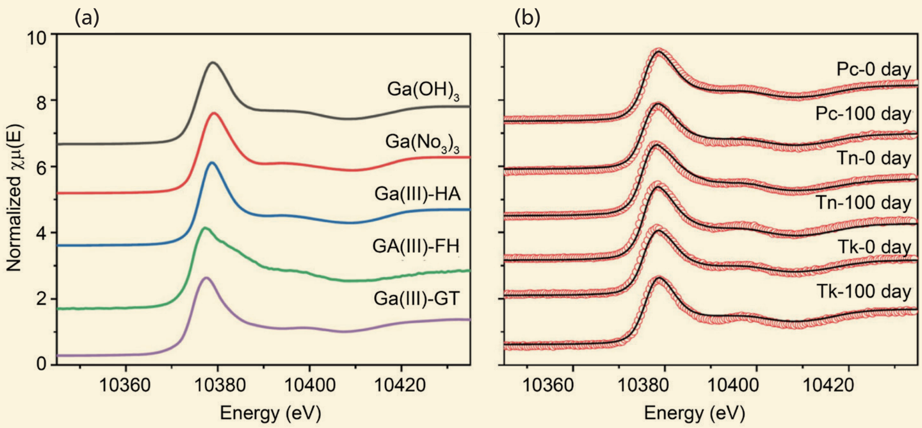

Fig. 3: (a) Ga K-edge X-ray absorption near edge structure (XANES) spectra of the reference compounds, including $Ga(OH)_3$, $Ga(NO_3)_3$, Ga(III)–humic acid [Ga(III)–HA], Ga(III)–ferrihydrite [Ga(III)–FH], and Ga(III)–goethite [Ga(III)–GT], for linear combination fitting. (b) Linear combination fits (solid lines) of the Ga K-edge XANES spectra (open circles) for three soils (Pc, Tn, and Tk) treated with 1.0 mmol kg^{-1} Ga before (Day 0) and after (Day 100) rice cultivation. [Reproduced from Ref. 1]

This report features the work of Shan-Li Wang and his colleagues published in J. Hazard. Mater. ***424****, 127582 (2022).*

TLS 17C1 W200 – EXAFS

- XAS
- Environmental and Earth Sciences, Chemistry

Reference

1. K.-Y. Chen, P.-T. Yang, H.-F. Chang, K.-C. Yeh, S.-L. Wang, J. Hazard. Mater. **424**, 127582 (2022).