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Article

Tantalum Recycling by Solvent Extraction: Chloride is Better than Fluoride.

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Abstract: The recycling of tantalum (Ta) is becoming increasingly important due to its criticality of supply from a conflict mineral. It is used extensively in modern electronics, such as in capacitors, and so electronic waste is a potentially valuable secondary source of this metal. However, the recycling of Ta is difficult, not least because of the challenges of its leaching and subsequent separation from other metals. In this work, we show that Ta(V) halides such as $TaCl_5$ and TaF_5, that can potentially be accessed from Ta metal upon acid halide leaching, can be recovered by solvent extraction using a simple primary amide reagent. The need for high halide concentrations in the aqueous phase implies the formation of the hexahalide salts $[TaX_6]^-$ (X = F, Cl) and that an anion-swing mechanism operates. While extraction of the fluorides is poor (up to 45%), excellent extraction under chloride conditions is found (>99%), and presents an alternative route to Ta recycling.

Keywords: tantalum; solvent extraction; WEEE; recycling; chemical separation

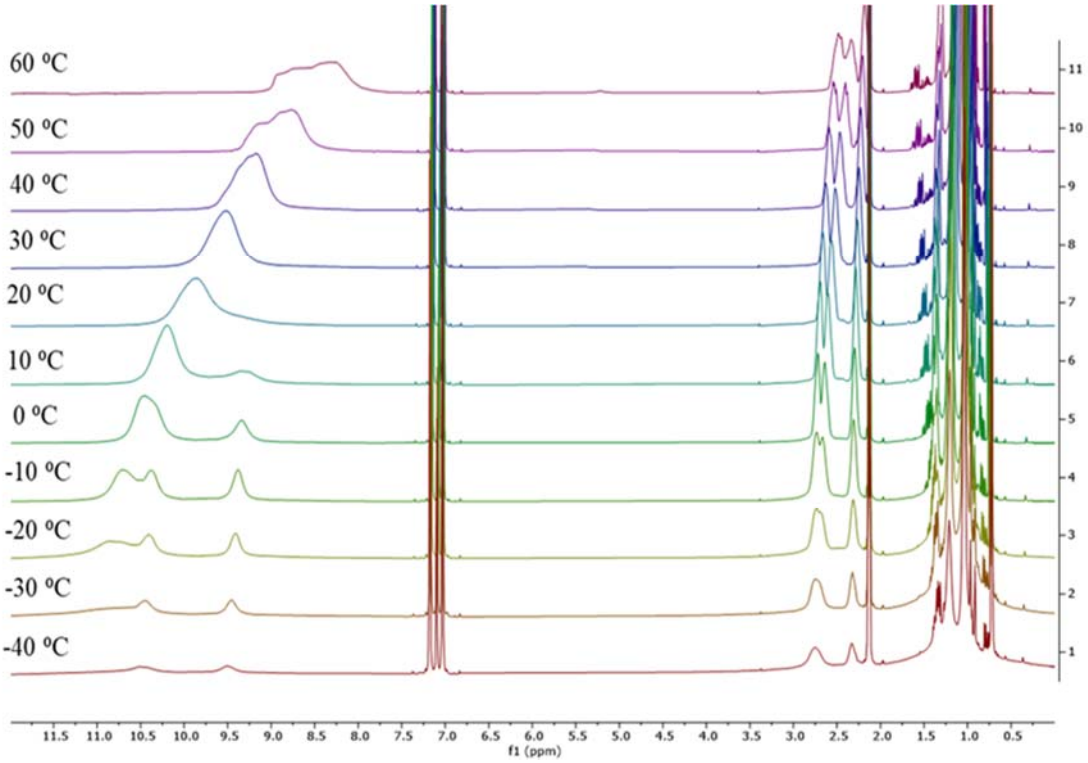

Figure S1. Variable temperature ^{1}H NMR spectra of 0.1 M **L** in *d*$_{8}$-toluene after contact with 0.01 M $TaCl_5$ in 1 M HCl and 9 M LiCl from −40 °C to 60 °C. Presence of additional water or hydronium signal is revealed amongst the signals assigned to the amide protons (between 8.5 ppm and 10 ppm) when the sample is cooled. Y-axes are offset for clarity.

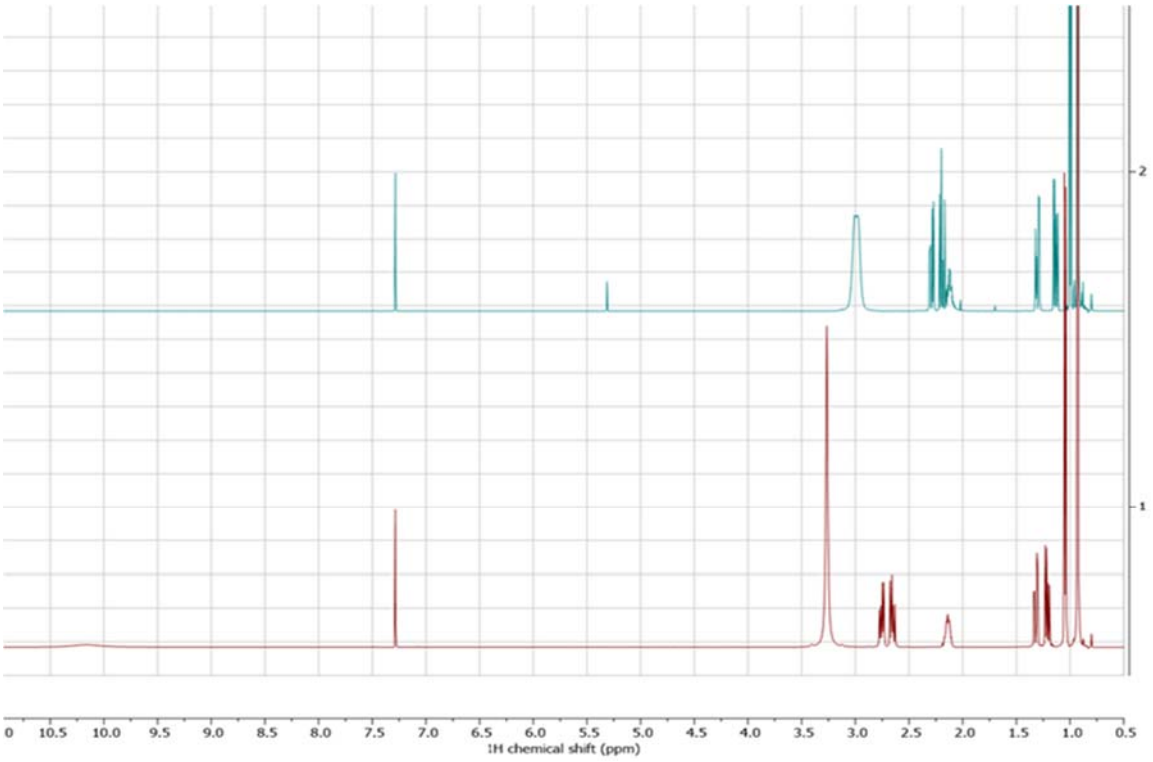

Figure S2. ^{1}H NMR spectra of a $C_{11}H_{23}NO$ (top) and $[H(C_{11}H_{23}NO)_2]_2[SnCl_6]$ (bottom) in $CDCl_3$.

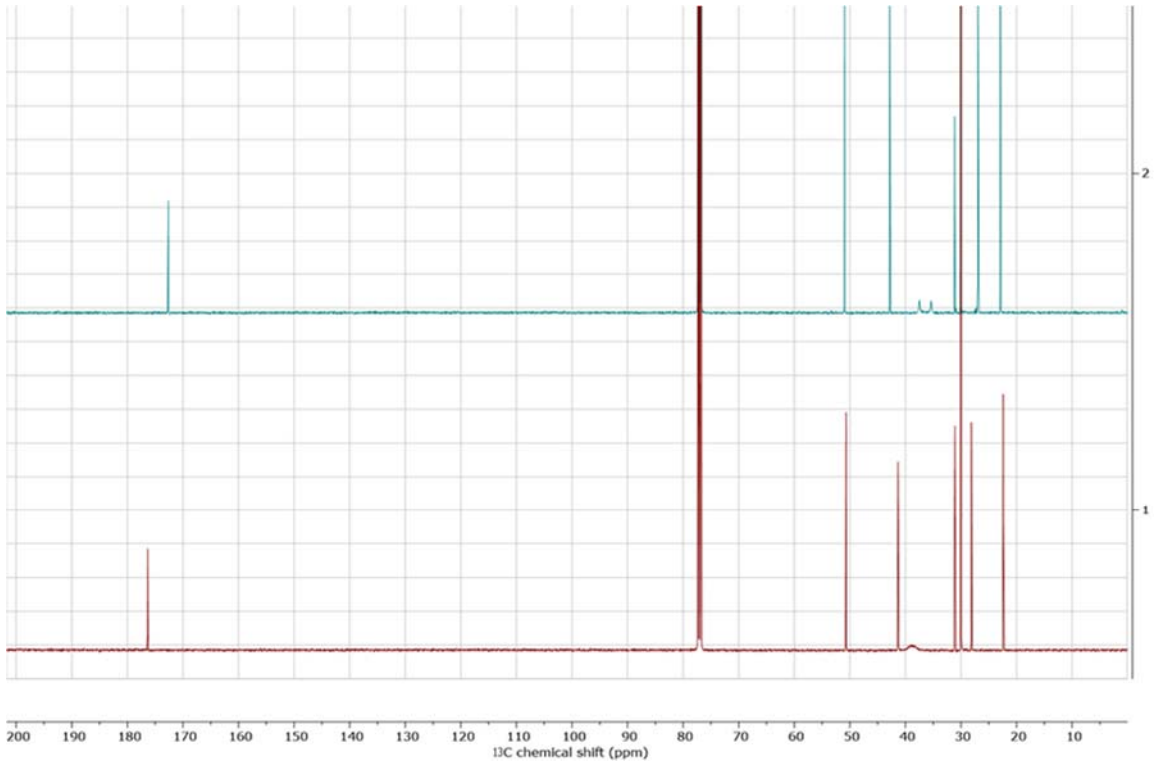

Figure S3. $^{13}C\{^{1}H\}$ NMR spectra of a $C_{11}H_{23}NO$ (top) and $[H(C_{11}H_{23}NO)_2]_2[SnCl_6]$ (bottom) in $CDCl_3$.

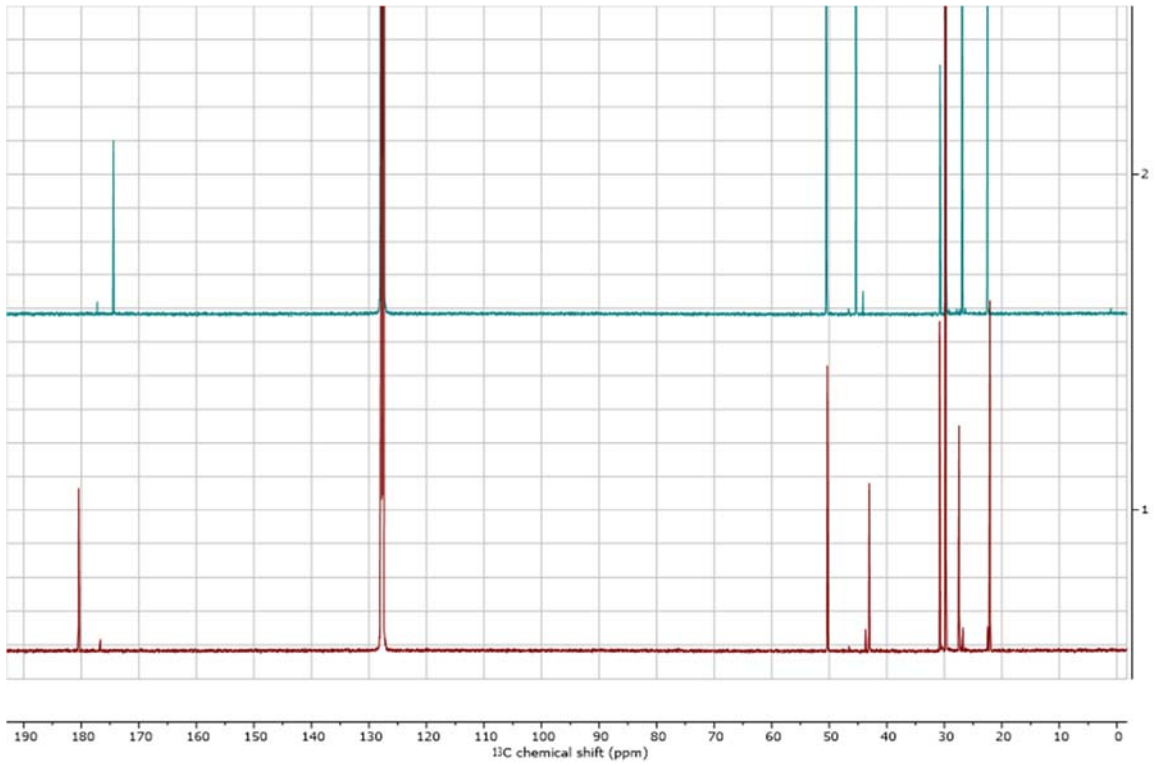

Figure S4. $^{13}C\{^{1}H\}$ NMR spectra of 0.1 M **L** in C_6D_6 (top) and 0.1 M **L** in C_6D_6 after contact with 0.01 M $TaCl_5$ in 1 M HCl and 9 M LiCl (bottom).