Chameleon behaviour of iodine in recovering Noble-Metals from WEEE: towards sustainability and "zero" waste

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Supporting Information

Chemical-physics characterization of the test specimen

The detailed chemical-physical characterization of the test specimen of WEEE was carried out using a multitechnique approach involving Scansion Electron Microscopy (SEM) with EDS Microanalysis system, Wide-angle X-ray Diffraction (WA-XRD), X-ray Fluorescence (XRF) and X-ray photoelectron spectroscopy (XPS), by means the equipments summarized in the experimental section of the paper.

SEM-EDS characterization

SEM investigation by EDS microanalysis, carried out on three different aliquots of the test specimen, showed: i) the significant presence of Cu; ii) Sn, Pb, Zn and Al in amounts below 10%; iii) Fe and Ni in amounts less than 1%; and iv) Ag in low amount. No presence of Au or other precious metals was detected. In Table S1 the average composition determined by SEM-EDS is reported. These results almost agree with the chemical composition obtained by ICP-AES analysis.

Element	Wt %
Cu	72.05
Sn	10.31
Pb	5.54
O	5.52
Zn	2.57
Al	2.43
Fe	0.60
Si	0.59
Ni	0.18
Ag	0.19
Cl	0.03
Total	100

Table S1 – Average composition obtained by SEM-EDS on three different aliquots of the test specimen.

A microanalytical characterization on selected grains of the test specimen has been also performed. Figure S1 point out the areas of investigation.

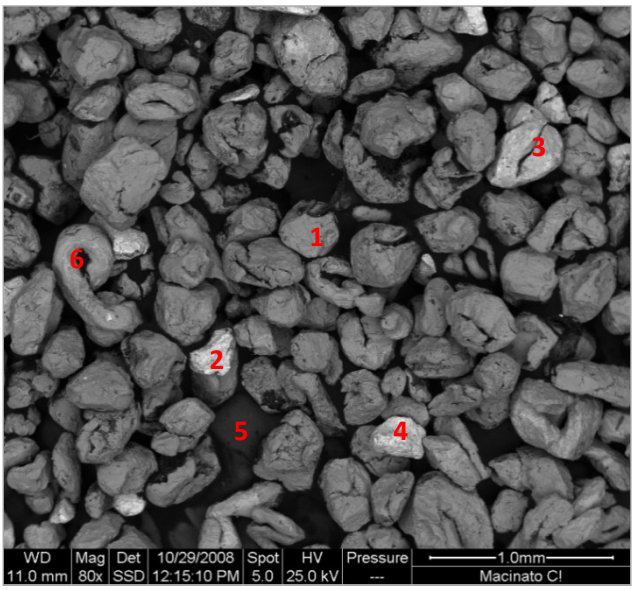

Figure S1 – Selected grains for microanalytical characterization.

Figure S2 collects the EDS spectra for grains 1-6.

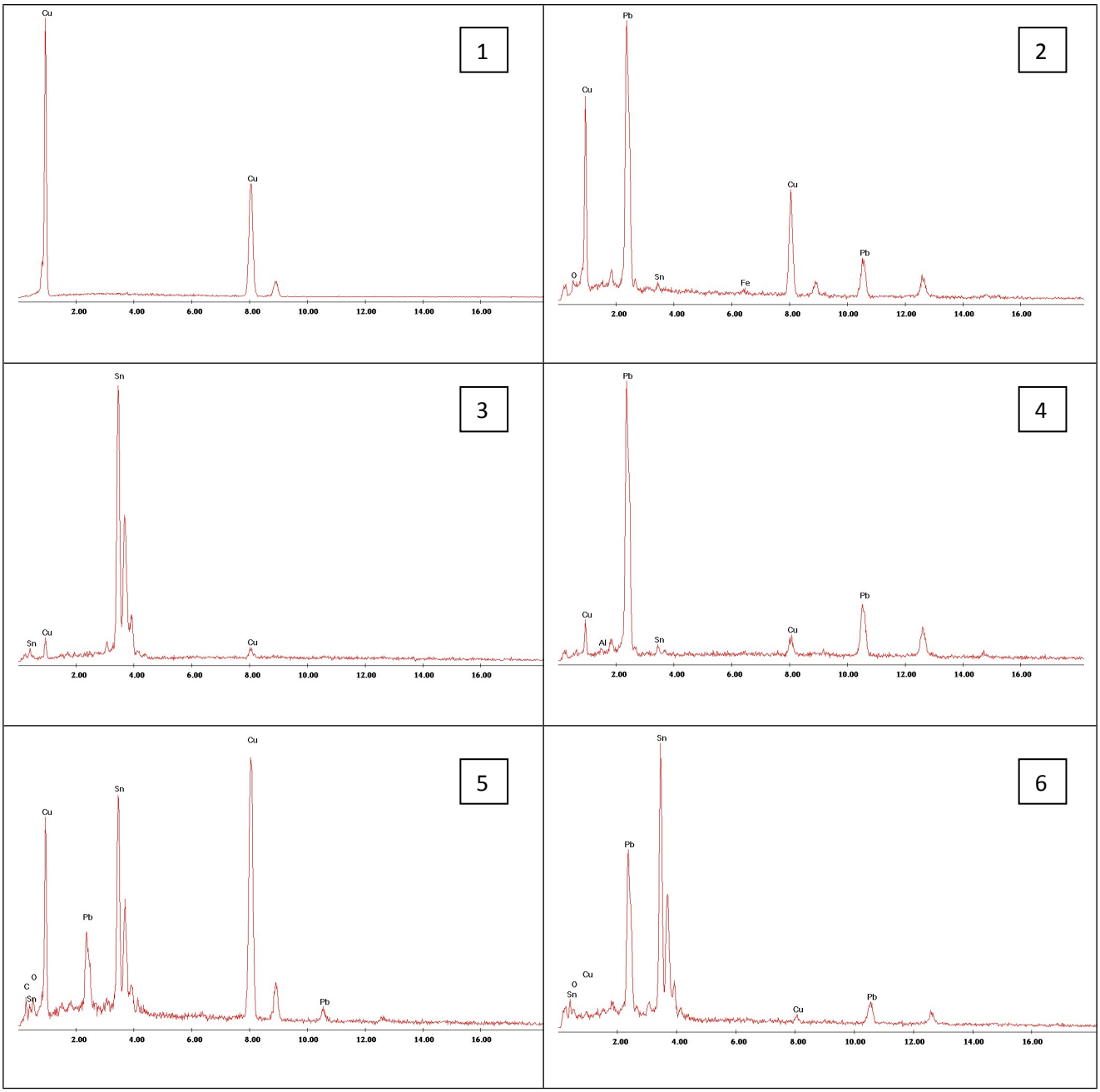

Figure S2 - EDS spectra for grains 1-6.

XRF and WA-XRD characterization

XRF and WA-XRD measurements allowed to confirm the presence of Cu (high amounts) and Pb while trace metals content was lower than detection limits. Moreover, the WA-XRD analysis indicated the presence of Sn, while the XRF analysis showed the presence of Zn and Fe (low amounts). In Figures S3 and S4 the WA-XRD pattern and the XRF spectrum of the test specimen are reported.

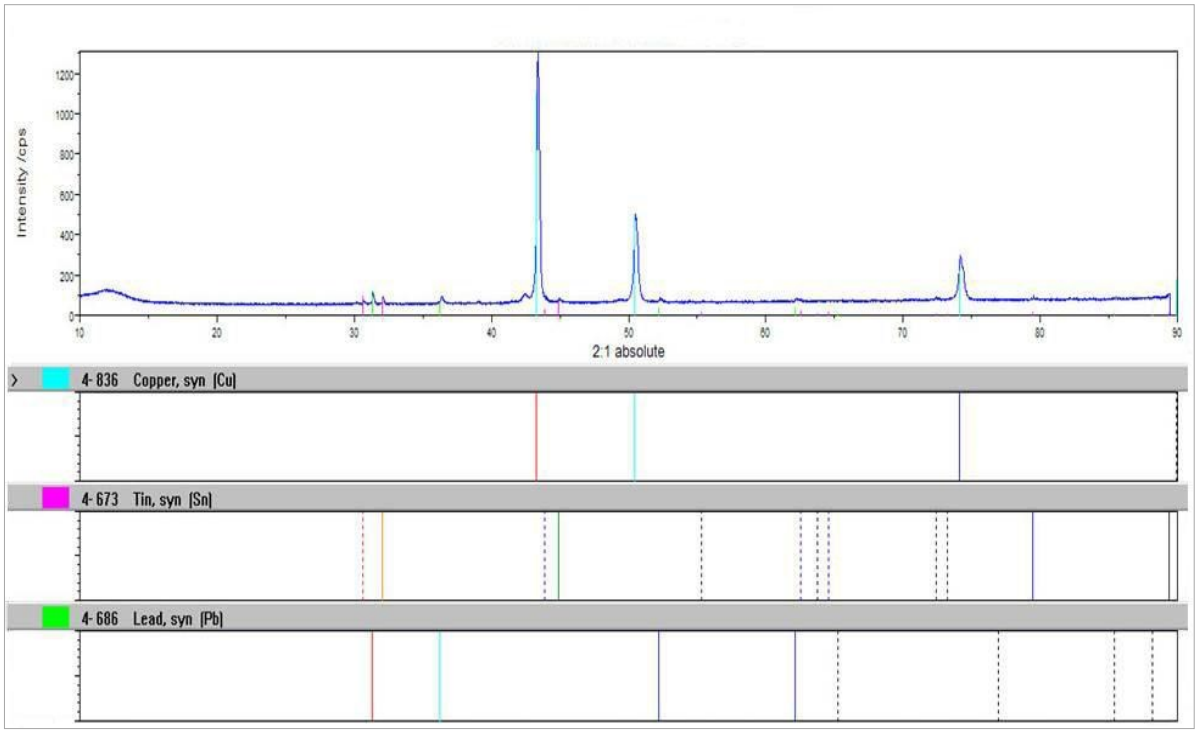

Figure S3 – WA-XRD pattern of the test specimen of WEEE.

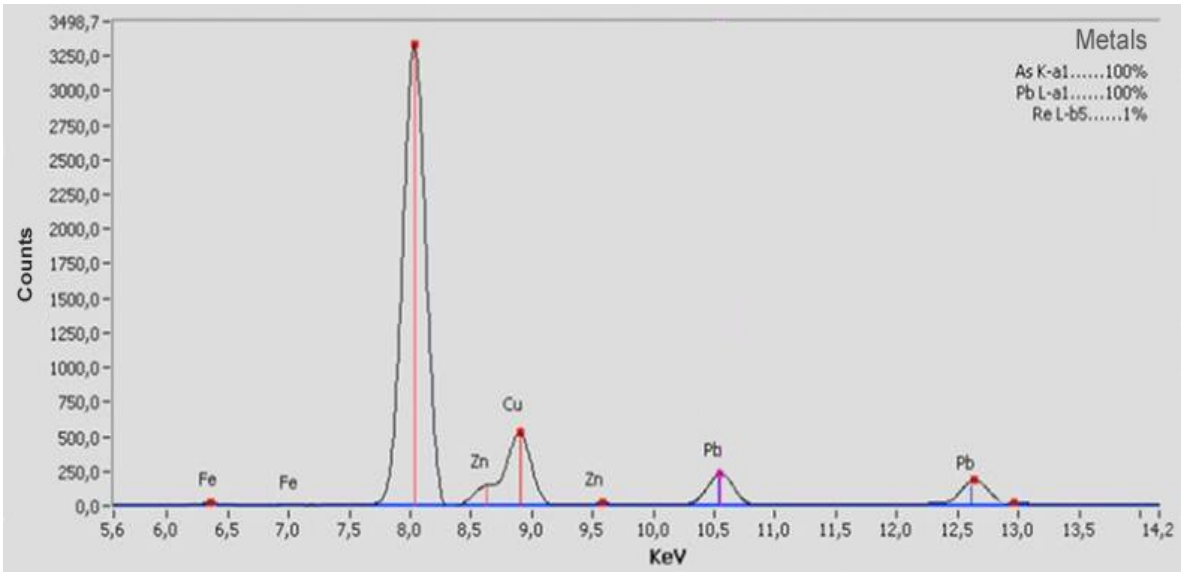

Figure S4 – XRF spectrum of the test specimen of WEEE.

XPS characterization

The XPS technique is diagnostic to determine the presence of oxides on the surface of the test specimen. The high resolution spectra (Figure S5), carried out on the surface of three different

grains of the sample, showed the presence of Cu, Pb and Sn. In particular, the Figure S6 indicates the presence of the following oxides and hydroxides: $Cu(OH)_2$, SnO_2 and $Pb(OH)_2$.

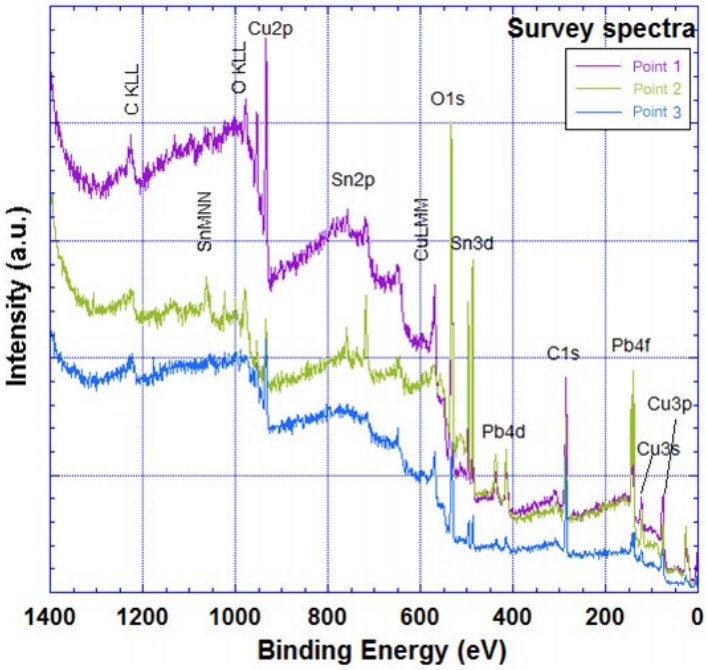

Figure S5 – Total XPS spectra of the test specimen of WEEE.

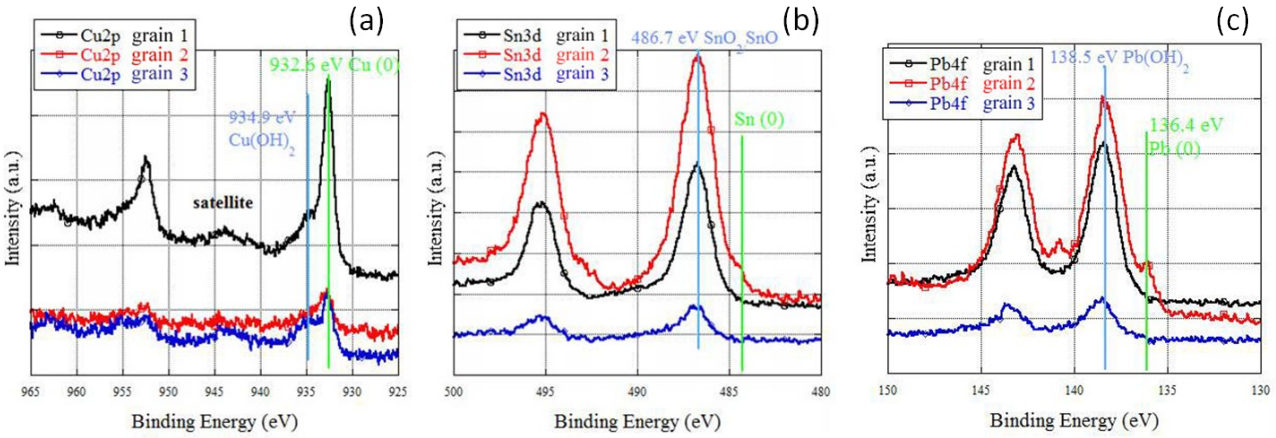

Figure S6 – High resolution XPS spectra of: a) Cu2p, b) Sn3d, c) Pb4f, on three different grains of the test specimen.

Comparison between the reactivity of the $Me_2dazdt{\cdot}2I_2$ organic solution and the I_2/I^- water solution towards gold

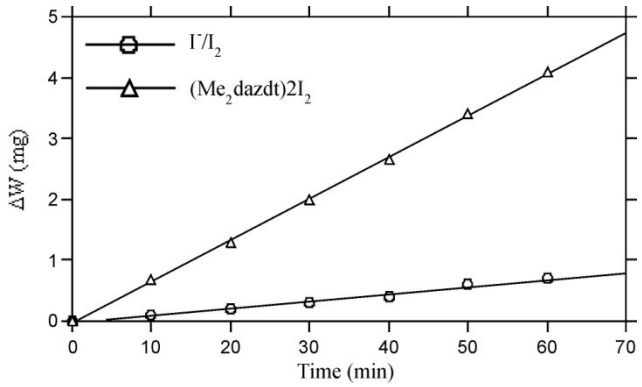

Figure S7 - Plot of the gold weight loss ΔW (mg) *vs.* the time (minutes) for calibrated wires of the same length and thickness dipped into equimolar solutions ($c = 5.0 \times 10^{-3}$ mol dm^{-3}) of $Me_2dazdt{\cdot}2I_2$ adducts in THF and I_2/KI in water.

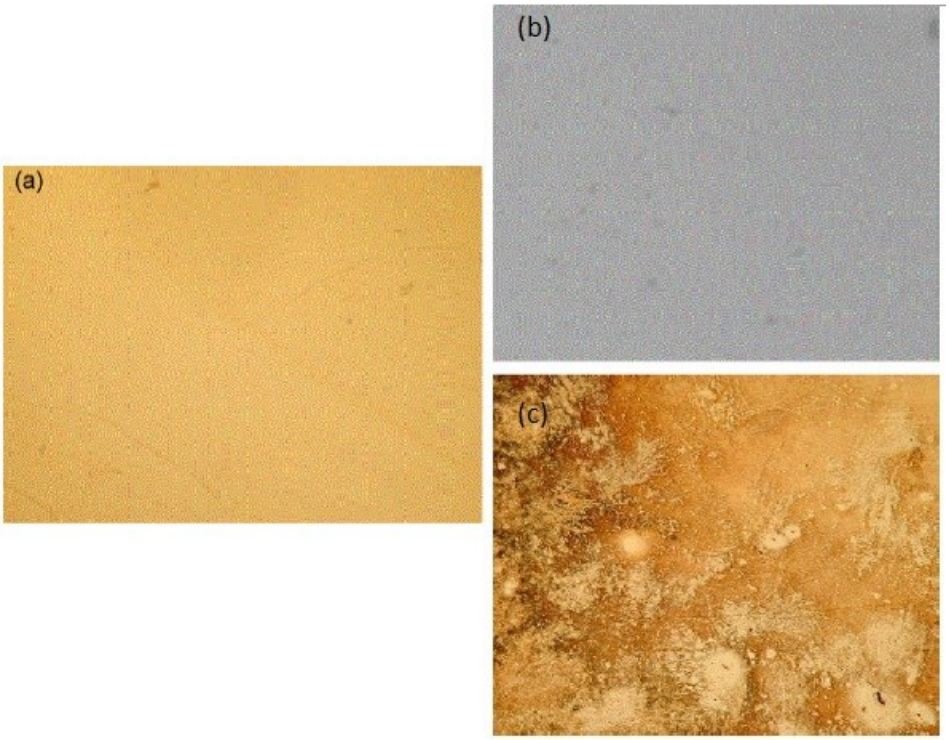

Figure S8 - $Si/SiO_2/Ti/Au$ thin layers before (a) and after 5' of etch by $Me_2dazdt{\cdot}2I_2$ THF solution (b), and I^-/I_2 water solution (c). $c = 5.0{\times}10^{-3}$ mol L^{-1}.