Comparative assessment of USEPA digestion methods for metals liberation and characterization of various printed circuit boards

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The continual and unprecedented consumer demand for electrical and electronic equipments (EEEs) with rapid technological advancement and accelerated product obsolescence has led to build up of electronic waste (e-waste) worldwide. Printed circuit boards (PCBs) make the foundation of EEEs constituting about 3-6% of their total weight and a significant portion of metals content of e-waste. High metal content of PCBs have necessitated a dedicated recycling process for the recovery of metals for economic development and also for waste treatment to avert environmental pollution. The prioritization of target metal to be recycled is motivated by the economics as well as environmental metrics and is largely influenced by the proportion of the metal in waste PCB. Though end-of-life PCBs are an integral and valuable constituent of e-waste, yet no devoted acid digestion procedure exists for determination of their chemical composition. Thus, the aim of this paper is to explore metal liberation analysis and to compare the existing USEPA acid digestion procedures, USEPA 3050B, USEPA 3051A as well as USEPA 3052 in effective metal dissolution from waste pulverized PCBs of computer, laptop, mobile phone, TV set. Results showed significant difference among the three acid digestion procedures with greater dissolution by USEPA 3052 method. The USEPA digestion methods showed significant variation in dissolution of the toxic metals with the maximum contents of Pb (2.26±0.08 wt.%) in TV PCBs, Cd (0.0812±0.0008 wt.%) in computer PCBs and Ni (0.100±0.002 wt.%) and Cr (0.0099±0.0004 wt.%) in mobile phone PCBs by the USEPA 3052 method. The SEM-EDS analysis for metal liberation demonstrated partial release of metals from the silicate matrix of PCBs. It was recommended from the present study that the USEPA 3052 digestion method can be used for effective dissolution of metals from e-waste for characterization prior to metals recovery and recycling.

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