Interlinked machinery for the automated disassembly, separation and recovery of valuable materials from electronic equipment – progress of the ADIR project

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Within the European project ADIR a consortium of R&D institutes and companies have developed processes and a machinery to demonstrate the feasibility of a novel approach for *inverse production* in terms of an automated selective disassembly of consumer and professional electronics. Target of the ADIR project is to gain a new quality of valuable sorting fractions of end-of-life (EOL) electronics with high enrichments of valuable materials by physical separation [1].

Mass streams of EOL electronics stem from mobile phones (MPH) and printed circuit boards (PCB) from servers and switching electronics for telecommunication purposes. Whereas for conventional production input materials and components are – as a rule – well known, the situation of *inverse production* is much more challenging. The variety of features of the material to be processed is very broad and often there is no or only little information available. Hence for an automated selective treatment the following processes are required:

- pre-sorting and singularisation of input material,
- image processing to recognise model types, orientations, positions of MPHs, PCBs
- robotic handling of MPHs and PCBs: picking, transfer, dismantling actions
- training of dismantling actions by test sets, working out sets of dismantling recipes
- detailed imaging of PCBs to localise position and volume of electronic components
- fast chemical analysis of selected electronic components to identify components with high concentrations of target elements
- fast selective desoldering of identified electronic components
- sorting of extracted components in fractions
- metallurgical processes adapted to pre-concentrated sorting fractions

Based on these requirements novel processes and an interlinked machinery was developed. Initial operations in laboratory and field tests were carried out. EOL MPHs stored in a bunker are fed to a system of transport lines to singularise MPHs on a belt conveyor where they are provided at the band head for picking by a robot. A robot picks single MPHs and transfers them to a dismantling station. Based on trained recipes the housing is opened, the battery extracted and discharged to a first sorting fraction. The PCB is taken out and transferred by a manipulator to the subsequent machines. A high resolution 2D/3D imaging is performed and implemented machine learing algorithms detect electronic components. By laser spectroscopy selected components are chemically analysed without contact to identify valuable materials. Hit scores for target element contents are generated. All data are fused in a central data base. Identified electronic components are desoldered by laser from the PCB and discharged to sorting fractions of e.g. tantalum capacitors. Novel schemes of hydrometallurgical recovery of target elements in these sorting fractions are worked out showing high levels of metal recovery.

[1] R. Noll et al, Proc. Europ. Metallurgical Conf. EMC 2017, 799-816