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Assessment of recyclability of modern printed circuit boards (PCBs) from technical, sustainability and economic perspectives

The development of concepts for the comprehensive recycling of end-of-life printed circuit boards (PCBs) is challenging because of their complex composition and the minute scale of the electronic components used. This is due to the fact that PCB design mostly considers achieving pre-defined performance indicators at lowest possible cost. Recyclability considerations, on the other hand, are still of little relevance to PCB design. This is despite the fact that recyclability will be imperative to reach the sustainability goals set by society. Achieving these goals may, in turn, demand important changes in PCB design strategies.
Based on the above, the recyclability of state-of-the-art PCBs is critically assessed in a current investigation. This investigation takes into account a wide range of circular economy aspects (e.g. minimization of resource consumption, reduction of toxic materials in production, and enhancement of recycling rate). The study places a particular focus on the opportunity to mechanically separate metals and plastics fractions using a comprehensive suite of mechanical separation technologies. These technologies exploit different physical properties of metals and plastics, e.g., density, magnetic susceptibility or conductivity. The separation efficiency and limitations of each of these technologies is assessed with particle-based separation models, accounting for the size, shape, and composition of particles in the experiments. The recyclability potential is then evaluated from exergy and life-cycle assessment perspectives. HSC Sim and openLCA software packages are used in combination for this task. Overall, the finding of this study will provide PCB designers with important insight on possible recycling rates, material selection, energy consumption during recycling and the environmental footprint of modern PCBs.

References

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