The shift to lead-free solders - assessed through attributional and consequential life cycle inventory

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Electronics packaging is a research field dealing with everything in electronics between the chip and the system including the solder interconnection materials. As of July 1st of 2006, lead will not be allowed in solder pastes. This has called for attention to evaluate the alternatives to lead-tin solders and especially the environmental consequences of the shift from lead-tin solder paste (LT) to lead-free solder paste (LF). A life cycle assessment (LCA) was initiated in 2003 with two aims:
- to compare a LT (62% tin, 36% lead, 2% silver) to a LF (95.5% tin, 3.8% silver, 0.7% copper); both pastes are assumed to include 10% flux, and
- to compare attributional and consequential LCA methodology.

The attributional LCA describes the environmental burdens of the solder life cycle. It describes, for example, the obvious fact that the shift from LT to LF means that lead is essentially eliminated from the solder life cycle. Our attributional LCA is largely based on literature data. Lacking environmental data for flux production, we used the economic input-output model from Carnegie Mellon to obtain proxies. Preliminary results from the attributional LCA indicate that LF contributes 10% more than LT to the global warming potential (GWP). Of the difference, 60% can be related to increased reflow energy consumption and 40% to increased tin production. Production of flux contributed about 5 % of the total GWP results for both solders.

The consequential LCA has just begun. It aims at describing how the environmental burdens of the technosphere are affected by a shift from LT to LF. It will describe, for example, to what extent the shift means that total lead use is reduced and to what extent it means that lead use will increase in other life cycles. We do not expect the consequential LCA to include all inputs to the solder because, for each input in the analysis, we need to investigate the supply curve as well as the demand curve, identifying price elasticities, marginal production, and marginal consumption.

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