Life Cycle Assessment of Micro Manufacturing

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In order to verify the assumptions and stereotypes concerning the environmental friendliness of the micro products, the application of Life Cycle Assessment (LCA) tools is getting widespread. According to the regular belief, the environmental impacts of the micro components seem to be less than their macro counterparts due to the small amount of material usage, less production energy and less quantity of waste. On the other hand, the design and manufacture of so-called micro parts plays an increasing role. Micro parts are usually defined by having critical dimensions in at least two dimensions below 1 mm or having functional features below 1 mm [**1**]. The small size is often seen as an indication of a smaller environmental footprint, but the manufacturing efforts are usually quite significant both in terms of machine sizes and energy consumption per weight unit of product [**2**]. Furthermore from a technological perspective, efforts associated with the creation of the necessary precision usually comprise use of auxiliary equipment and special materials as well as temperature and humidity control [**1**]. Finally, both in MEMS and other micro products the use of rare materials is often seen due to the small amount in use.

In the current research, a LCA approach is carried out for two micro products. The investigated micro parts are representative for two different sockets for signal carriage of hearing aid instruments. The LCA described in this study uses IMPACT 2002+ as the assessment methodology and the software SimaPro 7.3 as the LCA tool. In addition, by scaling a socket up to 25 times a macro component is assumed in order to compare the environmental impacts of a micro and a corresponding macro product. In each of the LCAs, gold and the process of coating are identified as the most hazardous material and process.

The significance of environmental impacts for macro components compared to micro components is achieved by defining a parameter as “impact ratio”. This parameter shows that how much the environmental impacts of a micro product are changed when the product is scaled up. Moreover, the environmental impacts of every micro and macro socket per unit weight of them is calculated by applying another parameter named “net impact” and the results reveals that the net impact of micro sockets is considerably higher than the corresponding one for macro sockets. The “net impact” is computed again after removing gold as the material which causes the most significant environmental impacts. The outcomes show that yet again the environmental impacts of micro per unit of weight is significantly more than those of macros which in turn leads to doubt over the hypothesis of environmentally friendliness of micros compared with macros. Moreover, the uncertainty of the results is estimated for the different scenarios by performing a sensitivity analysis and no considerable difference is observed except for varying the amount of gold.

REFERENCES:

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