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Material criticality assessment in early phases of sustainable product development

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Abstract

Improving structural performance of products is often realized by introducing increasingly advanced and complex materials as well as material combinations. What material to use in products is decided in the early product development phases and has a decisive impact for manufacturing, maintenance and end-of-life. A particular challenge is that the decisions need to be made upfront, where information of the forthcoming product is limited. This paper presents an early product development method to assess the criticality of alloy materials from a resource availability- and sustainability perspective. The method distinguishes itself from previous studies that focus on element criticality on a country level. The method is used to characterize and analyze the criticality of alloys in a three-step process that aims to support product design teams selecting what material alloy to use in early phases of design. It provides a proactive and systematic approach related to critical materials to avoid potential future problems on a long-term basis. The method presented has been developed in an action research-based approach in an aerospace company where a product design team validated and evaluated the material criticality method. The generic nature of the method is likely to be applicable not only to aerospace companies but also to other industries using advanced alloys. An important finding from applying the method in the company case was the clear link between long term business impact and sustainability performance.

Keywords: material criticality, early design phase, sustainable product development, decision support, eco-design

1. Introduction

Deciding on what materials to use for products is most often made in the earliest phases of product development and has a decisive influence on the remainder of the product's life (Giudice et al., 2005). For manufactures, both legislation and market trends towards service provision (Mont, 2002; Tukker and Tischner, 2006) result in retained ownership and responsibility of materials through the products' life. Uncertainty in future availability and supply of materials adds risks for manufacturers that need to be accounted for when deciding on materials. The criticality of materials from a full sustainability perspective (economical, environmental and social) is thus important to understand for decision making in the phases where material selection is done, i.e., in the early phases of product

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