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BOOK OF ABSTRACTS

Implementing sustainability in laboratory activities: A case study on magnetron sputtering deposition synthesis based on Life Cycle Assessment approach

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Abstract

Life Cycle Assessment is a structured and internationally standardized analytical tool to quantify all relevant emissions and consumed resources (ISO 14040-14044). Using Life Cycle Assessment is possible to analyze issues related to environmental and health impacts, and to the depletion of resources, associated with any good or process. Life Cycle Assessment covers the whole chain starting from the mineral extraction, and passing through the production, the use, the recycling, up to the disposal of the final wastes. This approach is known as “cradle to grave” analysis, indicating that the environmental impacts of the entire life cycle of products is considered. However, in research field, the typical approach is a “cradle to gate” analysis, where some phases are not considered, such as the use and the end of life ones, for instance.

Life Cycle Assessment studies of experimental activities are useful to identify the critical steps in terms of environmental impacts and can be useful to support the design and the optimization of the experimental set-ups, addressing to more sustainable laboratory activities.

In this work, a “cradle to gate” Life Cycle Assessment was carried out analyzing the experimental campaign of aluminum titanium nitride coating of commercial steel sheets by reactive physical vapor deposition magnetron sputtering. Aluminum titanium nitride is widely used material in many industrial fields as wear resistant coating in cutting tools, in bio-implants, in the aero-engine sector, as diffusion barriers in integrated circuits. The Physical Vapor Deposition is a scalable technique, and an environmental impact analysis assuming a great importance thinking to a technology transfer. Life Cycle Assessment is a suitable tool for this purpose, and it has been already widely used in many scientific, industry and policy sectors. Life Cycle Assessment results highlighted that the main driver of environmental impacts of the laboratory activities was the electricity used for instruments operations. The most energy consuming impact is related the vacuum keeping in the deposition chamber. In the second part of this study, several optimization strategies were evaluated to reduce the overall electricity consumption, with the aim of improving the environmental profile of experimental activities.