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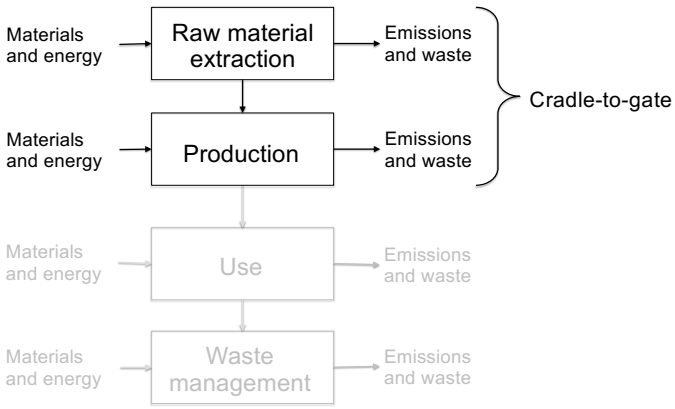
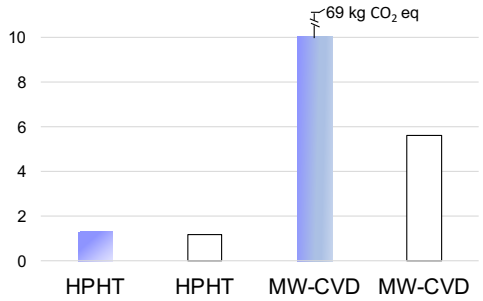
What are the Life Cycle Environmental Impacts of Synthetic Diamond?

OUR RESEARCH

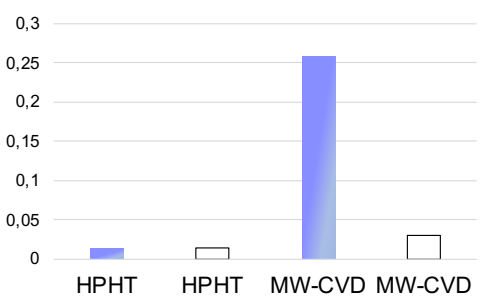
Synthetic diamond is conventionally produced via high-pressure high-temperature (HPHT) synthesis, while microwave chemical vapor deposition (MW-CVD) is also used but to a lesser extent. China dominates the global production of synthetic diamond. Life cycle assessment (LCA) is a method commonly applied to assess the environmental impacts of products. The product's entire life cycle (cradle-to-grave) or parts of its life cycle such as from raw material extraction to production (cradle-to-gate) can be included in an LCA. The purpose of this study is to assess the life cycle environmental impacts of synthetic diamond production via HPHT and MW-CVD synthesis, i.e. a cradle-to-gate LCA. Results are provided for the conventional production of 1 g diamond single crystals, < 1mm, via HPHT and 1 g diamond layer via MW-CVD.



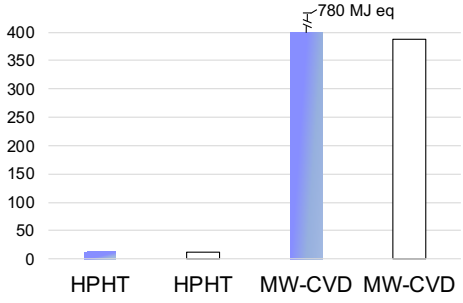
Climate change [kg CO_2 eq/g]



Terrestrial acidification [kg SO_2 eq/g]



Cumulative energy demand [MJ eq/g]



Electricity: Production mix, China, Guangdong ☐ Solar electricity

PRELIMINARY RESULTS

Preliminary results from the study indicate that the cemented carbide (WC-Co) parts required for the high-pressure apparatus and the metal solvent input constitute hotspots in the HPHT synthesis, while the required electricity constitutes a hotspot in the MW-CVD synthesis. Scenarios were constructed to assess the importance of the type of electricity mix applied in the production. This shows that the impacts are reduced by 3-8% and 51-92% in HPHT and MW-CVD production, respectively, when solar electricity is used instead of a Chinese electricity mix. Thus, changing the type of electricity applied in the production constitutes a large potential for improvement, especially for MW-CVD synthesis. The results from this study can be used in future full LCA studies, which then also include the use and waste treatment processes of the product under study.

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