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Development of bulk thermoelectric N-type SiGe alloy by laser powder bed fusion

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Abstract (150 mots max)

Like printing in its day, additive manufacturing has revolutionized current production methods in many areas like aeronautics, military or medicine. Among these methods, Laser Powder Bed Fusion (L-PBF) is prevalent to printing complex metal parts in small and medium series. Techniques developed recently in L-PBF pave the way for producing new types of materials via this method, including thermoelectric (TE) materials. This document presents the research work carried out at CEA to study the manufacturing of silicon-germanium alloy by L-PBF, a TE material intended for high temperature applications. In this study, we achieved successfully the printing of several dense samples, and then discuss their microstructures, chemical composition and thermoelectric properties.

Innovative aspects (150 mots max)

Additive manufacturing of TE materials is a recent topic, as it was first approached in 2015 by Ahmed El-Desouky et. al, by experimenting laser shots on a Bi2Te3 powder compact. Since then, several TE materials have been studied (MnSi, SnTe, SbTe, ZnNiSn ...) but there's no work published to this day mentioning L-PBF of SiGe. Consequently, our work is likely to be the first instance of SiGe manufacturing via this method.

Beyond that, L-PBF is a technique conceived initially for metal powder densification, and SiGe as a semiconductor poses unusual challenges for its development, such as heat dissipation mechanisms substantially different from those observed in metals, or the brittle aspect of the material.

Keywords

Laser powder bed fusion (L-PBF), Silicon Germanium (SiGe), Thermoelectricity, Additive Manufacturing, Powder metallurgy, Rapid solidification

What is the Purpose of the Project/Study?

What is the Purpose of the Project/Study? *	
In what way does the Project/Study Create Value and/or Make Life Easier? *	

Develop L-PBF techniques to produce bulk thermoelectric materials via this method (here SiGe)

First, L-PBF allow a large variety of shapes, specifically curved modules that suit more efficiently heat sources shapes, which enhance their yield. Second, printing directly TE legs avoid the cutting phase, and material losses linked to this step.