Automated production of prototype modules from industrialized Half-Heusler material

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The industrialization and automation of material and module manufacturing technologies is one of the important topics to reduce the costs of thermoelectric technology. The company Isabellenhütte Heusler is engaged in the industrialization of Half-Heusler based thermoelectric technology.

The Isabellenhütte Heusler GmbH & Co. KG has a long tradition in Heusler compound research. The great grandfather of our CEO Dr. Felix Heusler was Dr. Fritz Heusler. He found the first Heusler alloy in 1901 at Isabellenhütte. Unfortunately there was no economic use for this kind of compounds for the company up to day.

Since 2009 the Isabellenhütte has been actively involved in Heusler alloy research again. Since then we have been working on thermoelectric Half-Heusler compounds. Our purpose is the development of a melt metallurgical manufacturing process for these materials, which is able to be industrialized. We have also a focus on the development of thermoelectric modules using our Half-Heusler materials. In 2017 the Isabellenhütte built up an industrial pilot line production, which starts with the raw elements and ends up with thermoelectric modules. The ambition is to demonstrate an industrial scale material manufacturing and an automated assembling process of Half-Heusler modules in a constant high quality.

Now the project is in the process development phase. It has already succeeded to produce first 10 kilogram batches of P-type and N-type materials. With our Half-Heusler pilot production line we are able to produce customized single legs out of the 10 Kg ingots (figure 1.). In the framework of the EU-H2020 funded project INTEGRAL it is planned to enlarge the production scale up to 50 Kg batches.

Fig. 1. Industrial Half-Heusler manufacturing line

Due the industrialization of the thermoelectric module manufacturing, Isabellenhütte developed a two-step module design concept. The first step is the production of an unicouple. We start with the thermoelectric legs from the pilot line production and assemble each one P-type and one N-type leg on top of a hot side contact. The second step is the mounting of many unicouples on the surface of a special cold side substrate without the clasical massive ceramic sheet (figure 2.). In this way it is possible to produce different modules with one type of unicouple.

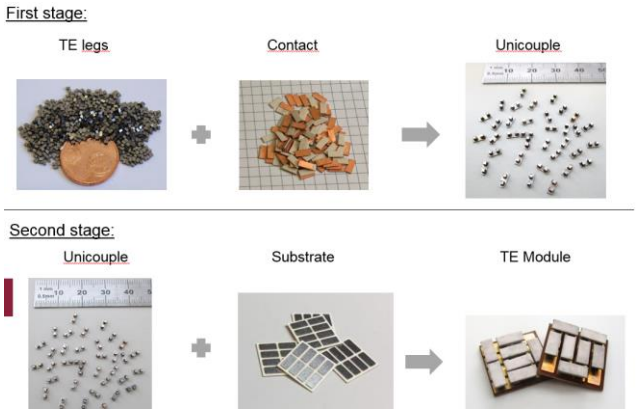

Fig. 2. Two step manufacturing of a thermoelectric module

Isabellenhütte has built up a first automated production line for this type of thermoelectric modules to investigate an industrial manufacturing. The line has a theoretical production capacity of 5.8 million unicouples p.a.. This amount of unicouples is enough to equip 50.000 modules with a size of 40mm by 40mm.

Isabellenhütte developed a first standard module with 40 x 40 mm² for qualification testing and customer sampling (figure 3.). At the moment we are producing a series of 100 standard modules with the automated equipment to perform a design validation test.

Today we are able to show the automated manufacturing and first test results of this standard module.

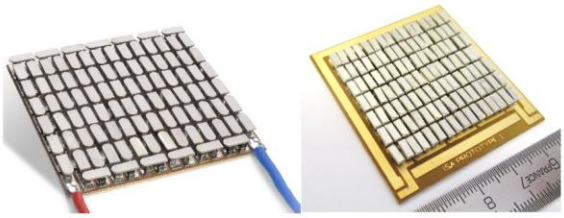

Fig. 3. Prototype modules from industrial like production