Global analysis of the assembly of Fe_2VAl and metal electrode through the study of the bonding process conditions.

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Fe_2VAl-based thermoelectric modules are very promising for large scale applications such as industrial energy harvesting since its constituent materials are abundant, non-toxic and low cost. However, the assembly of modules based on Fe_2VAl compounds requires to properly bond this thermoelectric material to high electrical conductivity material such as copper. Furthermore, the assembly must remain efficient in the entire range of temperature at which Fe_2VAl compounds show interesting thermoelectric properties, which means from 300K to 700K. At these temperatures, thermal ageing may induce significant modification of the microstructure at the interface between thermoelectric material and electrical conductor. Moreover, copper is known to show poor oxidation resistance above 500K in atmospheric conditions and replacement by pure nickel or nickel-plated copper should be considered [1].
To understand the influence of the bonding process on the property of the assembly, we propose a global analysis based on characterization of the interface microstructure, measurements of surface contact resistance and Seebeck coefficient of a junction as well as the assessment of the effect of thermal ageing [2].
We tested a panel of joining technologies and discriminated some processes based on the global analysis. The most promising technique is the use of a high temperature (1000K) silver-based brazing compound under high vacuum condition (10^{-4} mbar). This process leads to low surface contact resistance ($<10\mu\Omega\cdot cm^2$), the appearance of a thin reactive layer at the interface, a weak change on the Seebeck coefficient and no major degradation of the assembly properties after heat treatment. Furthermore, those results were obtained for all three of copper, nickel-plated copper and nickel electrodes. Finally, this bonding process has been upscaled to manufacture a complete thermoelectric module with 36 thermoelectric legs and 37 electrodes in an induction vacuum furnace.

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[2] ROY, G. *et al.* Global Analysis of Influence of Contacts on Heusler-Based Thermoelectric Modules. *Journal of Electronic Materials*, 2019, p. 1-13.