Wide and Ultra-wide bandgap power devices: key technologies to undertake the electrification and decarbonisation challenge

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Abstract

Industry and transportation electrification based on a deep deployment of renewable sources (solar, wind, etc.) is one of the tools foreseen to reach the decarbonization objectives for 2050. This process will involve some critical issues, such as the transport, distribution and conversion of the electric energy, in an efficient, flexible and reliable way through smart grids. Power electronics is one of the main key enabling technologies required for achieving these targets. Among the more challenging elements to be developed, are the high power modules implementing the switches required in the conversion circuits, based on wide-bandgap (WBG) and ultra-WBG (UWBG) semiconductor power devices. With SiC and GaN technologies established for devices below 10 kV [1], the first research works on diamond have started few years ago aiming at developing very high voltage, current and operation temperature transistors (breakdown voltages above 15 kV, working temperatures above 300ºC). Other UWBG semiconductors such as Ga_2O_3 recently appeared as candidates for the development of the required power switches in flexible and high-power capability smart grids, although they are in the first stages of material research. Other key factors affecting the development of this new generation of high power devices must also be considered. First, their packaging and integration has become itself an additional challenge, boosting the research on new materials and assembling methods [2]. Integration technologies play also a major role in the implementation of new converter concepts such as the switching-cell-array approach [3] aiming at improving the converter performances through “full semiconductor” and modular solutions. Second, there is a lack of characterization tools specifically devoted to the analysis of the electro-thermal and reliability issues of the new generation of devices [4]. This work, will present a review of these technologies.

REFERENCES

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FIGURES

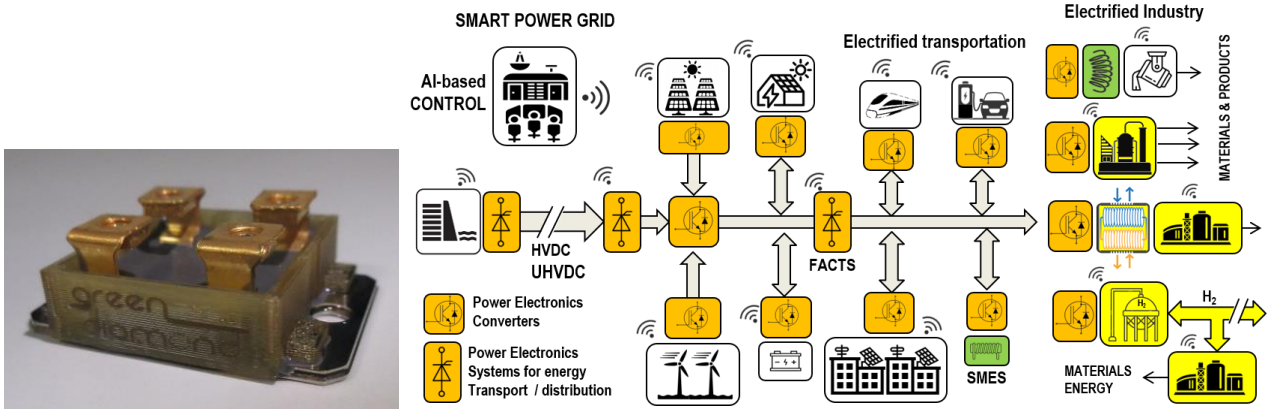

Figure 1: New power electronics devices are key elements in the future smart grid scenario