Abstract

The use of acoustic emission in the diagnosis of marine power equipment
on the example of semiconductor power devices

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The presented dissertation is a proposal for the use of acoustic emission (EA) signals for the diagnosis of semiconductor systems, particularly those used in the propulsion equipment of vessels and similar ones installed in offshore systems/structures. In addition, the possibility of testing the aforementioned systems at or approaching their limits is presented. A measurement path investigating the effect of a semiconductor system's condition (technical) on the changes in the elastic wave of acoustic emission has been developed and described. The dependence of the change in the operating temperature of the component, on the bandwidth of the emitted frequency of the elastic wave, was presented. Tests were carried out, which confirmed that acoustic emission of power semiconductor elements occurs during their switching and is recordable. Failure analysis of IGBT transistors was performed. Acoustic emission descriptors were presented and their application in relevant semiconductor circuit studies was proposed. Existing similar studies related to the diagnosis of IGBT transistors have been analyzed, and differences in the interpretation of their results have been pointed out, among others, proving the errors of some of them. The studies described in the paper approximate the analysis of elastic waves emitted by semiconductors and their dependence on thermal changes during switching, with different coefficients of thermal expansion of the materials used for the construction of the element. An analysis of EA signal events at higher frequencies caused by changes in current flowing in the circuit is made. Various methods of recording and interpreting acoustic emission signals were presented. Both available measurement apparatus (e.g., a measurement path using an oscilloscope) and the latest available EA measurement and recording equipment from Vallen and MISTRAS were used. Also used as a measurement track constructed at the Maritime University of Technology in Szczecin with a modified EA recorder previously dedicated to the diagnosis of modern marine engine injection systems and to the analysis used in materials engineering when studying discontinuities (defects) in materials. Measurements carried out by the author led to the demonstration of the existence of an acoustic emission signal in semiconductor elements and the assignment of specific frequency bands (spectrum) that can be attributed to the corresponding phenomena occurring in the semiconductor element.