Public Abstract

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Title: Silicon Carbide as a photoconductive switch material for high power applications

Pulse power switches have traditionally been gas discharges 1 such as thyratrons and spark gaps. They have been implemented in high power pulsed lasers, power conditioning systems, impulse radar, high power microwave generators, and various other applications. Disadvantages of these switches however include large size, jitter, longer onset times, limited power handling capabilities, maintenance etc. Optically activated semiconductor switches on the other hand offer a number of advantages over these conventional switches such as picosecond jitter, nanosecond closure, higher current density, controllable current conduction time, high blocking electric field, and improved voltage level, simultaneous or phased closure of many switches, small size and low loss conduction. These advantages make optically activated switches a desirable component in these applications. Photoconductive semiconductor switches are considered for this analysis. Silicon carbide is a new emerging material as a PCSS material because of its advantages like high temperature, high power, long bandgap, and durability over previously available gallium arsenide and silicon counterparts.

This research work discusses the effort at the Electrical and computer engineering (ECE) department at the University of Missouri Columbia (UMC) in developing this technology through simulation and experiments with SiC material. Specifically, the rationale for employing extrinsic photo-conductivity, the role of compensation mechanisms have been demonstrated, modeled, and analyzed. The device material fabrication methods and package structures developed to date are discussed. The behavior and the response of the two compensated structures have been discussed in terms of recombination time and optical sensitivity. Material characterization showing agreement with the experimental results was based on choosing the right parameters on trap levels and compensation mechanisms. The experimental switching results with both intrinsic and compensated SiC photo switches using sub-bandgap photon energy for code calibration and high power PCSS analysis is presented and compared with semiconductor physics models. The methods used to determine the density and recombination cross section of interband dopants is also presented. A method to improve the hold off voltage of the PCSS by many orders of magnitude is proposed. Laser illumination data with the improved design is also presented.