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DARK CURRENT BEHAVIOUR ANALYSIS FOR AVALANCHE PHOTODIODES *

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In the last few decades the technologies to produce high quality semiconductors materials have rabidly improved as the demand on them has increased which led the scientists to pay more attention to these materials and their properties. One of the most advanced photodetectors nowadays is the avalanche photodiodes due to their high performance and their operating conditions [1].

Since the demonstration of molecular beam epitaxy which widened the ability to establish more applications based on semiconductor materials, and after the big success of QDIP for infrared detection, a lot of attention has been paid to the quantum discoveries, this has stimulated the development of avalanche photodiode and its ability for single photon detection [2]. Small-sized and high-performance photonic devices were recently integrated thanks to a monolithic integration approach. Such achievements were obtained with the help of two group-IV materials: silicon (Si) and germanium (Ge) [3]. The use of group-IV materials seems optimal for the future needs of monolithic chip integration [4].

An ideal APD should possess high avalanche gain, low dark current, small bias voltage, and detect high-speed optical signals of up to 100 Gbit/s. Ge-APDs based on metal semiconductor metal (MSM) structure feature high avalanche gain at low bias voltage and are compatible with semiconductor silicon transistor processes. However, such MSM schemes suffer from limited avalanche gain, large dark current, and reduced receiver sensitivity.

For Ge-APDs based on the separate absorption-charge-multiplication (SACM) structure, thanks to the confining carrier multiplication in intrinsic Si, devices benefit from low multiplication noise and impressive gain-bandwidth product (GBP) [5].

In this work, the avalanche photodiode were investigated, some calculations were done and highlighted. The results of these calculations will be shown and analyzed in order to widen our prospective in infrared detection area.

This work discusses the behavior of avalanche photodiodes under certain conditions and emphasizes the dark current characteristics. First, we comprehensively study the opto-electrical properties of avalanche multilayer photodiodes of germanium with silicon quantum dots then we analyze the results with a lot of consideration to the dark current characteristics in several modes and under different conditions and parameters.

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