Microcontroller-based Custom Test Module for Multifunctional Sensor for Radiation Environments

Adeyemi Taylor, Shuza Binzaid, John Attia
Electrical Engineering Department
Prairie View A&M University Texas

Abstract

Most of the non-transmitted diseases, like cancer, are a major area of research in health. Causes of cancer in the body that have been identified include various electromagnetic emissions and ionizing radiation. Solutions to detect these dangerous environments at early stages can save many lives through the application of the multifunctional sensors, and the electronic modules. Many sensors are already developed and available today but still very short in multifunctional sensors, that can detect more than one type of radiation environment. To design a system that is suitable for both space and earth environments in detecting hazardous conditions that can cause fatal diseases, eight Multi-functional sensors were designed and successfully tested under the highest flux of neutron energy radiation at Los Alamos National Laboratory. Initial findings from this work have shown that it is possible to have a single multifunctional sensor that can detect two environments. These sensors had the same diameter of radiation window so that collected data can be compared. This novel design of sensors can be useful on earth and in space technologies in the near future.

Introduction

Health is always a concern for today's technologies that have high-frequency signal emission. The power lines spread around homes create sensitive electromagnetic harmful networks. Hospitals and industries have many microelectronic and micro-controlling systems. The circuits in systems may malfunction, and even have a catastrophic failure due to electromagnetic emissions, and ionizing radiation effects. In order to protect them from such failures and harmful incidences, it is needed to design sensors that are compact and multifunctional which can be used in systems to monitor both on earth surface and in space applications. Ionizing radiations such as X-rays and gamma rays are electromagnetic radiations known to cause cancer [American Cancer Society]. In order to protect humans from harmful electromagnetic and particle radiation environments, it is desirable to design multifunctional sensors that can be used to monitor both earth and space radiation environments.

Design and Testing Procedures

Eight Multi-functional sensors were designed by using five types of polymer materials and tested. These polymers were applied as single and dual layers in the design. These sensors were first tested very successfully under X-ray at Electrical and Computer Engineering department's Microelectronic Test lab at Prairie View A&M University, Texas, USA. Then they were verified for ionic air test in the special test setup at the university. To further proof the concept, the same sensors were tested at Los Alamos National Laboratory (LANL) under the highest flux of neutron energy radiation. These can be used in space technologies in near future. Images of two of these sensors are shown in figure 1. Real time processing of signals was achieved using a microcontroller running a customized Arduino code. The micro-controller monitors the outputs of the sensors and provides supply voltage to the sensor and then, outputs all the data on the serial output for further analysis. Figure 2 and 3 shows the arduino serial output of the sensors while under the effect of radiation at different time intervals.

(a)

(b)

Figure 1: Metal Induced Poly (a) and Carbon Induced Poly (b)

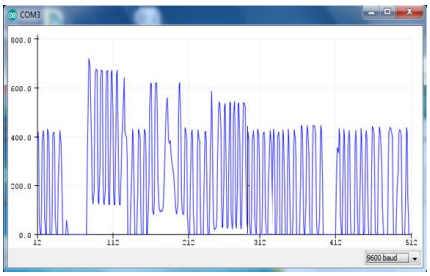

Figure 2: Sensor with Metal Induced Poly

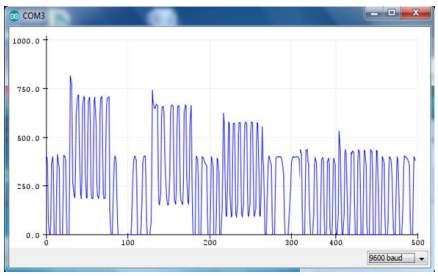

Figure 3: Sensor with Carbon Induced Poly

Conclusions

So far, results obtained have shown that it is possible to have a multifunctional sensor that can detect more than one type of ionizing radiation. Work to be done includes designing newer materials, making sensor system compact, and developing sensor driving electronics. In addition, we are currently developing an equivalent electronic circuit to simulate what is obtainable in the physical environment in order to provide an insight into the operation and behavior of the sensor circuit. It is envisaged that the product of this work will be the development of compact multifunctional sensors that will alert users of hazardous environments caused by ionizing radiation and electromagnetic emission. The multifunctional sensors being developed may be used for space technology, satellites, medical, handheld mobile and IoT devices.

References

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ADEYEMI TAYLOR
Adeyemi is currently a PhD student of the Electrical Engineering Department at Prairie View A&M University Texas.

SHUZA BINZAID and JOHN ATTIA
The above named individuals are researchers in the SMART Center at Prairie View A&M University.