Chapter 3
Design of RF Rectenna on Thin Film to Power Wearable Electronics

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ABSTRACT

This chapter reports a hybrid wearable energy harvesting system. Integration of microwave antenna on thin film amorphous silicon solar cell creates a hybrid system that can harvest both the solar and microwave energies. The antenna designed on solar cell will harvest the microwave energy at dual frequencies 1.85 GHz and 2.45 GHz with an effective return loss of 28dB and 27dB respectively. A complete hybrid harvesting system consist of a flexible solar cell, antenna, voltage doubler, and impedance matching dual band filter. The rectifier, designed on a rigid glass-reinforced epoxy substrate, is a voltage doubler and a matching circuit is designed by microstrip lines is used.

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INTRODUCTION

Power consumption of Semiconductor devices are significantly reduce and now these device are operate at ultra-low power levels. So, that energy harvested from environment will sufficient to run the electronic circuits. Much of electronic devices are compact in size, handy and coming with more powerful features which made daily life comfortable. Nowadays wearable technology is developing area based on energy harvested being used to power the integrated devices into clothing like sensors, LED displays and to charge the super capacitors etc.

Mostly the energy can be harvested from solar, piezoelectric, microwave (Radio Frequency) energy sources to power low, ultra-low power electronics, sensors or to recharge thin super capacitors. The energy harvesting technology will reduce weight burden on dismounted soldiers in terms of batteries to carry, no maintenance cost, all mostly power can regenerate from environment which extend the charging cycle. Researchers are inventing new technologies, materials which has less weight and flexible to wear or integrate into clothing. Flexible solar cell based energy harvesting have been reported using pollymide thin film photovoltaic smart bracelet for healthcare application, measuring the heartbeats of a patient through photoplethysmography (PPG) (Jokic and Magno, 2017; Wu, Arefin, Redoute and Yuce, 2017). Inductively power transfer circuit is designed on plastic with flexible solar cell as a power source (Hu et al., 2012), an intelligent hardware based charging controller circuit is presented for wireless sensor application (Li, Yin, Au-Shi, and Ronghua, 2015).

The conversion of ambient microwave power into DC power has been done by a circuit called rectenna. Usually rectenna consists of a radio frequency (RF) receiving antenna and a rectifying circuit. Solid dielectric substrate antennas are more common in use, they made with a printed copper on a dielectric substrate. The concept of wearable or textile antenna are having possible way to power the incorporated electronic devices with maximum efficiency.

In hybrid energy harvesting system energy can be harvesting from multiple sources, such as a low cost compact solar/electromagnetic harvester designed on flexible polyester (Vera, Gianfranco, Georgiadis, Apostolos, Collado, Ana, and Via, 2010), dual band rectenna was implemented on flexible polyethylene terephthalate PET substrate (Collado and Georgiadies, 2013), multi-input multi output three source solar, vibration and thermal