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New Optically Controlled Frequency-Agile Microstrip Antenna

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A novel class of microstrip antennas composed of organic semiconductor polymer [poly(3-hexylthiophene) (P3HT)] is proposed for frequency sweeping applications. The permittivity of the P3HT film is measured using the reflective coaxial method for illuminated and nonilluminated states. Resonant frequencies of the proposed antennas instantly change on changing the optical illumination intensity from an adjustable white-light source. Two different antenna configurations (square and square ring) are designed and tested experimentally. The square ring antenna is able to sweep a broader frequency band (1.5 GHz). The gain and radiation efficiency of the proposed square antenna are compared with the corresponding copper microstrip antenna. The proposed antennas have acceptable resonant and radiation characteristics, albeit with modest radiation efficiency.

Key words: Frequency-agile microstrip antenna, optically controlled antenna, multifrequency operation, organic semiconductor polymer

INTRODUCTION

Today's mobile wireless devices contain a multitude of different radios providing numerous services, spread across an ever-widening range of frequency bands. Future devices will undoubtedly need to support additional emerging wireless standards, and potentially cognitive-radio levels of agility,[1] creating an enormous engineering challenge at the physical layer of these systems. While Moore's law has allowed electronics to scale so that all these radios can fit on a few chips (or less), antennas do not scale in the same way. Designers must therefore create either a device incorporating multiple antennas to cover the frequency band associated with each service, or a single multiband antenna that adequately covers them all. The latter approach is more desirable in applications where space is a major constraint, but fixed multiband antennas can be challenging to design. Furthermore, multiband antennas require a significant amount of filtering circuitry so the receiver can handle increased interference from other bands, and crosstalk from transmit circuits using the same antenna. Frequency-agile antennas (FAAs)[2] are a unique class of antennas that have an operating frequency (or multiple frequencies) that can be dynamically manipulated in accordance with the bands that need to be serviced by the system. As such, the antenna can be shared by each of the services on the user's terminal, thus reducing the space required for the multiband antenna while potentially reducing out-of-band interference. Frequency agility is usually achieved by manipulating some physical or electrical characteristics of the patch, for example, by using moving mechanical parts, or by integration of controllable solid-state elements (diodes). Varactor diodes[2–4] and PIN diodes[5–7] have been used to produce frequency agility. There are many emerging technologies that promise to change the landscape of frequency-tunable antennas. Microelectromechanical systems (MEMS) technology is particularly promising. MEMS switches have already been explored for use in patch-based[8] and slot-based[9] designs, offering many advantages because of their low loss and high linearity. Interesting MEMS antennas based on a variable-air-gap patch[10] and unfurling patch antenna designs[11] have also been presented, with

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