Figure 7, moving the integrated strip monopole and the shielding metal case along the top edge of the system ground plane is expected to result in a variation in the coupling between the strip monopole and the system ground plane. This variation in turn affects the impedance matching of the strip monopole, and it is seen that the obtained impedance bandwidth is larger for a smaller value of d. That is, when the shielding metal case is flush with the side edge of the system ground plane, a maximum impedance bandwidth can be achieved. Also note that for d varied from 12.5 to 25 mm, the obtained results are the same as shown here due to the symmetric structure of the T-shape strip monopole, and thus the results are not shown here for brevity.

4. CONCLUSION

A novel design of an integrated low-profile T-shape strip monopole for UMTS internal antenna in a mobile device has been proposed. The low-profile strip monopole was short-circuited to the RF shielding metal case to form an integrated element, which can lead to a compact arrangement of the internal monopole antenna and associated nearby RF module and components in a mobile device. Good impedance and radiation characteristics of the integrated strip monopole over the UMTS band have been observed, and the effects of the shielding metal case on the performances of the integrated strip monopole have also been analyzed.

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ANTENNA-COUPLED INFRARED FOCAL PLANE ARRAY

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ABSTRACT: *Uncooled bolometric detectors used in infrared-imaging systems have slow time constants (~15 ms), which makes them impractical for fast-frame-rate applications. Antenna-coupled microbolometers are fast uncooled detectors with good sensitivity and directivity, and they can be polarization and wavelength selective. These detectors have collection areas in the order of 10 μm^2, which are too small for infrared imaging systems where a typical pixel area ranges from 20 × 20 μm^2 to 50 × 50 μm^2. To solve this problem, 2D arrays of antenna-coupled detectors, which can be used as pixels in infrared-imaging systems, are fabricated. In this paper, antenna-coupled pixels are fabricated on a commercial readout integrated circuit (ROIC), resulting in the first antenna-coupled infrared focal plane array (IR-FPA). Measurements made on this antenna-coupled infrared focal plane array show that the integration of antenna-coupled detectors to a commercial ROIC is possible.* © 2005 Wiley Periodicals, Inc. Microwave Opt Technol Lett 48: 165–166, 2006; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.21294

Key words: *IRFPA; focal plane array; antenna-coupled detectors; microbolometers; ROIC*

1. INTRODUCTION

Bolometers are resistive elements constructed from materials with a high-temperature coefficient of resistance (TCR) so that a small amount of absorbed radiation will produce a large change in resistance. These bolometers are operated by passing a bias current through them and monitoring the voltage across them, a change in the output voltage will reflect changes in resistance [1].

The size of bolometers used in commercial infrared imaging systems is around 50 × 50 μm^2, which is the size of a typical pixel area. A bolometer of this size will have a time constant of around 15 ms, which is slow for certain applications [2]. By reducing the size of a bolometer, a lower amount of energy will be needed to increase its temperature, which will result in more sensitive detectors [3]. A smaller bolometer will also have a smaller time constant that can be useful for high frame-rate applications. The problem of reducing the size of a bolometer is that less energy gets collected, since bolometers use their physical size to collect radiation. A way to increase the collection area of a small bolometer is to couple an antenna designed to resonate at the desired wavelength; hence, we can have fast detectors without sacrificing collection area [3].

Different types of antennas have been coupled to sub-micron-sized bolometers and their performance has been tested [4]. These antennas have collection areas in the order of 10 μm^2, which is too small for infrared imaging systems since current readout integrated circuits (ROICs) have typical pitch sizes of 20 × 20 μm^2 to 50 × 50 μm^2. In order to solve this problem, 2D arrays of antenna-coupled detectors have been fabricated to cover a whole pixel area [5]. In this paper, 2D arrays of antenna-coupled detectors have been fabricated on a commercial ROIC, resulting in the first antenna-coupled infrared focal plane array (IR-FPA).

2. METHOD

Commercial ROICs were provided by Raytheon to integrate antenna-coupled pixels monolithically onto them and make an antenna-coupled IR-FPA. The ROICs provided had a 1.2-μm layer of SiO_2 and a 500-nm layer of Si_3N_4 as passivation layers. In order to avoid a high step profile between the detectors and the ROIC, this passivation layer was thinned down to 250 nm using CF_4-based reactive-ion etching (RIE).

A CAD file in GDSII format for the top metal layer of the ROIC was also provided by Raytheon. Using this file, the exact coordinates of distinctive features on the ROIC (that is, letters, numbers or previous alignment marks) can be located in order to align to those features during the e-beam patterning process. Global and local alignment marks were then aligned to existing structures on the ROIC and placed using e-beam lithography and liftoff.

Openings on the passivation layer were made to uncover the ROICs contact pads by using CF_4-based RIE, the contact-pad

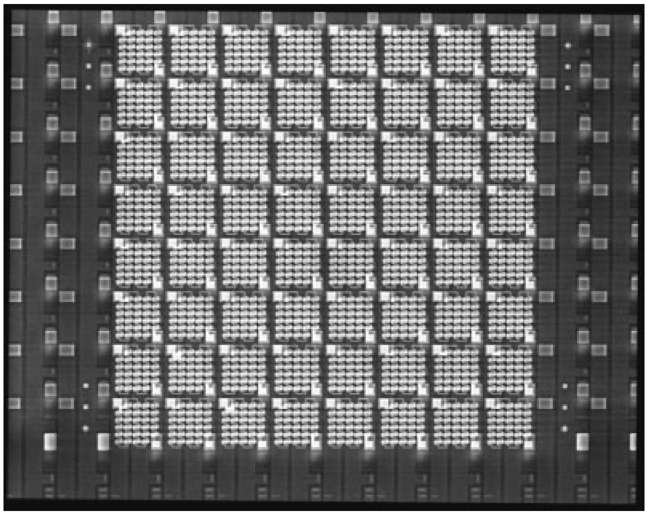

Figure 1 8 × 8 pixel array of antenna-coupled infrared detectors

openings were patterned using e-beam lithography, and PMMA was used to mask the RIE process. After contact openings were made on the ROIC, the standard fabrication process explained in [5] was used to pattern the antenna-coupled pixels. These antenna-coupled pixels consisted of 2D arrays of log-periodic antennas. Figure 1 shows the 8 × 8 pixel array fabricated on the Raytheon ROIC and Figure 2 shows a pixel element of that 8 × 8 array.

3. RESULTS

Log-periodic antenna-coupled pixels were fabricated on a commercial ROIC covering a region of 8 × 8 pixels. After the monolithic integration of antenna-coupled pixels to the ROIC was performed, the antenna-coupled IR-FPA was bonded and mounted in a dewar custommade for that particular ROIC. The IR-FPA was tested with a black-body at 100°C using the same camera emulator used to test commercial infrared imaging systems and based on that ROIC. Figure 3 shows the image obtained with the 8 × 8 array of log-periodic antennas looking at the 100°C black-body, which shows a successful integration of antenna-coupled infrared pixels to commercial ROICs. From Figure 3, it is also evident that work needs to be done in order to increase the responsivity and the homogeneity of these antenna-coupled pixels.

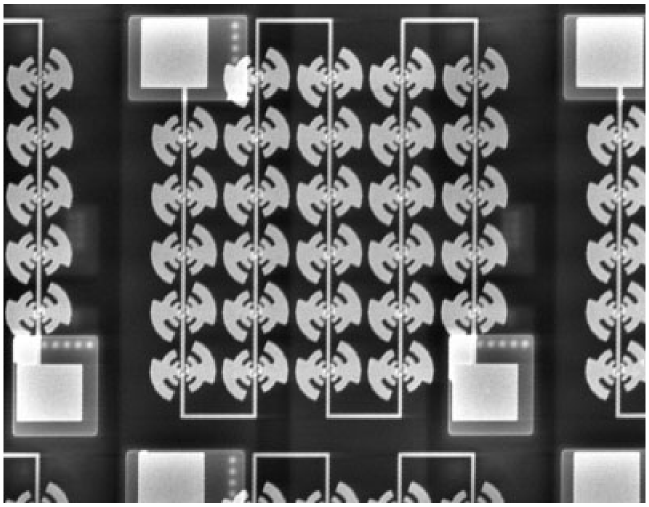

Figure 2 Antenna-coupled pixel

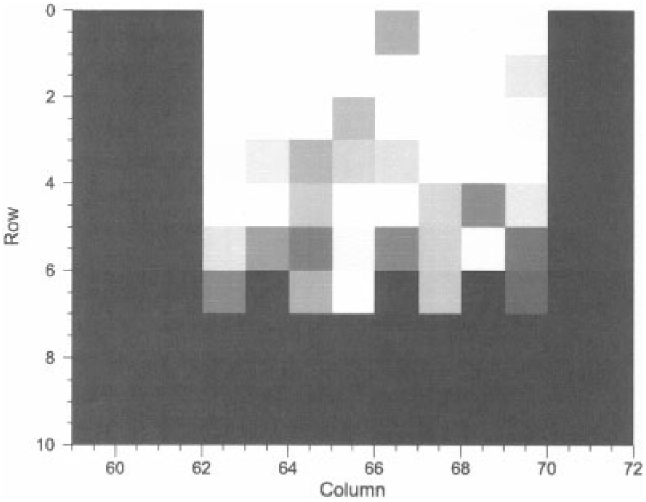

Figure 3 Hot source imaged by an 8 × 8 array of antenna-coupled pixels

4. CONCLUSION

An 8 × 8 array of antenna-coupled pixels has been fabricated on a commercial ROIC by using e-beam lithography and conventional microfabrication techniques, resulting in the first antenna-coupled infrared focal plane array. The IR-FPA was tested with a black-body at 100°C using a camera emulator used to test commercial infrared-imaging systems. Measurements made on this antenna-coupled infrared focal plane array showed that the integration of antenna-coupled detectors to a commercial ROIC is possible. Antenna-coupled pixels still need to improve their responsivity and homogeneity in order to be a viable option for commercial infrared-imaging systems.

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