Triple-layer complementary FSS for the Isolation Enhancement of Relay Antenna Arrays

Jinxin Li[1], Shiwen Yang[1], and Zaiping Nie[1]
[1]University of Electronic Science and Technology of China, Chengdu, 611731, P. R. China

Abstract*—A novel triple-layer complementary frequency selective surface (FSS) for the isolation enhancement of relay antenna arrays is proposed in this paper. Simulated and measured results show that the proposed FSS can improve not only the isolation of the same polarization ports nearly 5dB over the frequency band of 2.5—2.7 GHz, but also the isolation of the cross polarization ports. More important, the backhaul antenna still keeps good performance with VSWR<1.5 and stable radiation pattern, while the metamaterial cavity is loaded.

I. INTRODUCTION

As one important auxiliary means for the wireless coverage, wireless relay technology have been applied and studied widely for its attractive features such as simple construction, less investment and convenient installation. According to the operation frequency bands of backhaul and access, this technology can be classified into two modes: inband and outband. However, whether inband or outband, the port isolation between the receiving and transmitting antennas is one of the most important factors that influence the performance of the relay node and repeaters.

A variety of different decoupling methods and isolation enhancement technique for multi-antenna systems and antenna arrays have been proposed in recent years. A decoupling technique using the circuit approach for improving the isolation between two closely spaced antennas of the same frequency has been proposed in [1]. Some discrete lumped elements are used to implement this lumped circuit networks. With the proposed decoupling structure, the isolations between antennas were greatly improved from 3 dB to more than 20 dB at the center frequency. However, this technique often requires circuit debugging, which could be difficult to avoid a great deal of adjusting work of the parameters of the capacitors and inductors. A isolation enhancement technique of the antenna array is achieved by studying novel antenna elements in [2-3]. The mutual coupling [2] among the antenna elements is 5 dB better than the conventional square patch antenna. With the same element spacing of half a free-space wavelength at 5.8 GHz, the mutual coupling [3] is suppressed by more than 3.1 dB. The isolation of [2] and [3] are just better than about 15.5 dB and 20 dB, respectively, which is not very high and attractive. More importantly, this methods are not suitable for port isolation enhancement of two closely-positioned antenna arrays.

The experimental results in [4] show that by using this combined structure of the mushroom-like EBG and choke structure of metal wall, the isolation level can be improved by at least 30 dB in the radar's operation band. The efficiency and improvement are very attractive, but the combined structure is also extremely large with the size of 5.75 λ^3 (λ is the free-space wavelength at 11.5GHz), which can be hardly applied in many engineering applications. The paper [5] proposed a novel artificial periodic structures with the characteristics such as compact size and easy of fabrication. The isolation level of the same polarization ports can be improved by at most 8.9dB over the band of 2.5GHz -2.7GHz, but the isolation of the cross polarization ports is not getting any better.

In this paper, a novel triple-layer complementary FSS for the isolation enhancement of relay antenna arrays is proposed. The proposed FSS are printed on the three sides of the four sets of double-layer vertical substrates. The four sets of triple-layer FSS can be grouped together with the reflector to form a rectangular metamaterial cavity for the backhaul antenna. Both of the port isolation with the same polarization and the cross polarization can be improved nearly 5dB over the frequency band of 2.5—2.7 GHz, while the *VSWR* is better than 1.5 and stable radiation pattern with high gain is achieved.

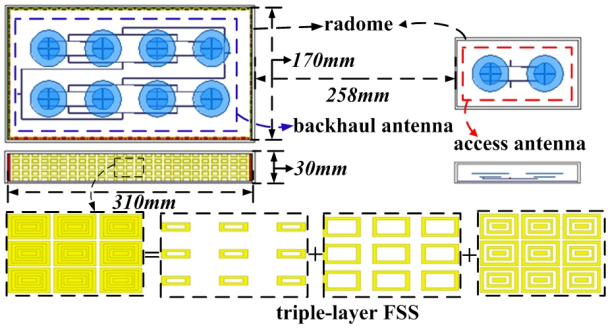

Fig. 1. Geometry of the antenna arrays and FSS: top view (top), side view (middle) and geometry of the triple-layer FSS.

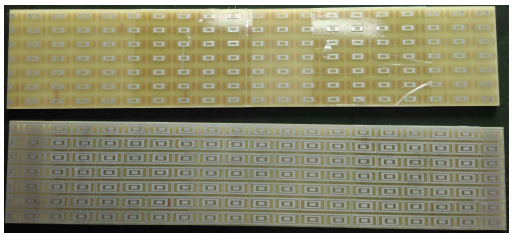

Fig. 2. Photograph of the proposed triple-layer FSS.

REFERENCES

[1]. S. Chen, Y. Wang, and S. Chung, "A decoupling technique for increasing the port isolation between two strongly coupled antennas," *IEEE Trans. Antennas Propag*., vol. 56, no. 12, pp. 3650–3658, Dec.2008.

[2]. K. Wong, L. Chiu, and Q. Xue, "A 2-D Van Atta array using star-shaped antenna elements," *IEEE Trans. Antennas Propag*., vol. 55, no.4, pp. 1204–1206, Apr. 2007.

[3]. L. Chiu, Q. Xue and C. Chan, "Phase-conjugated arrays using low conversion-loss resistive phase-conjugating mixers and stub-loaded patch antennas," *IEEE Trans. Microw. Theory Tech,* vol. 56, no. 8, pp. 1764–1773, Aug. 2008.

[4]. L. Qiu, , F. Zhao, K. Xiao, S. Chai, and J. Mao, "Transmit–receive isolation improvement of antenna arrays by using EBG structures," *IEEE Antennas Wireless Propag. Lett.*, vol.11, pp.93-96, 2012.

[5]. J. Li, S. Yang, Y. Gou and Z. Nie, "Wideband dual-polarized magnetically-coupled patch antenna array with high port isolation," *IEEE Trans. Antennas Propag*., under review.