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Near-Field Absorption and Measurement Using a Metasurface Structure

Satoshi Yagitani*, Takuya Tsubota, Naoki Tonooka, Mitsunori Ozaki, and Tomohiko Imachi
Kanazawa University, Kanazawa 920-1192, Japan, e-mail: yagitani@is.t.kanazawa-u.ac.jp

A thin metamaterial absorber was used for the measurement of 2-d radio-frequency (RF) field distributions incident on the absorber surface. A mushroom-type metasurface with a dense matrix of square metal patches was constructed on a grounded dielectric substrate. Absorption was achieved by lumped resistors interconnecting the surface patches, when the metasurface impedance was matched with the incident wave impedance at the resonance frequency. The distribution of an RF field illuminating the absorber surface was obtained by monitoring the voltages on the individual lumped resistors, which were generated by the incident electric field components along the resistors. A system was fabricated to measure and visualize 2-d RF (GHz) power and phase distributions of the spherical wave field radiated by a dipole antenna [1]. Effectiveness of the technique was evaluated and validated by theoretical (numerical) calculations, simulations, and experiments [2]. Since the technique relied on the matched absorption, its performance was confirmed for plane-wave incidence, as well as for spherical-wave incidence in the radiating near-field region, where the incident wave field was characterized to have the free-space impedance. Such obtained field distributions should give useful information for in-situ and real-time localization of radiating RF sources located more than a few wavelengths away.

For identifying electromagnetic interference occurring between components and systems in electronic devices, it is important to evaluate electric and/or magnetic couplings between sources and victims. In such a case not only radiating near-field but also reactive near-field distributions should be measured with high spatial resolutions at closer distances than a wavelength. In this study the absorption on the metasurface is evaluated of the reactive near fields generated by an RF electromagnetic source, and the possibility is discussed of measuring the near-field distributions using the metasurface structure. Preliminary numerical calculations using plane-wave expansion of reactive near-field distributions have shown that evanescent components play an important role in determining the absorbed field distributions on the metasurface. In the presentation we will discuss the performance of the metasurface to absorb the reactive near fields generated by a nearby RF dipole, using numerical calculations and simulations. Accuracy of the measurement of the reactive near fields by the metasurface structure is examined.

1. R. Kanaura, R. Hayashi, S. Yagitani, T. Imachi, M. Ozaki, Y. Yoshimura, and H. Sugiura, “Development of a system for measuring power and phase distributions of radio waves,” *Proc. URSI AP-RASC 2016*, August 2016, pp.1651-1653, doi:10.1109/URSIAP-RASC.2016.7601183.

2. S. Yagitani, R. Kanaura, M. Ozaki, and T. Imachi, “Numerical analysis and visualization of spherical waves absorbed by a thin metamaterial absorber,” *Proc. ICEAA 2017*, September 2017, pp.808-809, doi:10.1109/ICEAA.2017.8065372.