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Transparent antennas: From 2D to 3D

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Transparent antennas are very attractive. They can be integrated with clear substrates such as window glass, or with solar cells to save surface areas of satellites. Transparent antennas are normally realized using (2D) planar structures based on the theory of patch antenna. The optical transparency can be obtained by fabricating meshed conductors or transparent conductors on an acrylic or glass substrate. Transparent designs using the meshed-conductor approach are straightforward because optical signals can pass through the opening of the meshes, while microwave signals can be transmitted or received by the conductors. The transparency and antenna property can be optimized by refining the width of the mesh. In this talk, results of a transparent antenna with meshed conductors will be presented.

In the transparent-conductor approach, transparent conductive films are used as radiators. Commonly used transparent conductive films include indium tin oxide (ITO), silver coated polyester film (AgHT), and fluorine-doped tin oxide (FTO). A sheet resistance of at least 1-2 ohm/square is required to obtain an optical transmittance of better than 70%. However, antennas made of such transparent conductor films are not efficient because of the high sheet resistance. This is one of the major obstacles to the widespread application of transparent antennas. A method that alleviates this problem will be discussed in this talk.

For a long time, transparent antennas have been of planar (2D) structures. Very recently,

3D transparent antennas have also been developed. This is a new topic. The principle of 3D transparent antenna is based on the theory of dielectric resonator antenna; the resonance is caused by the whole 3D structure rather than a confined cavity as found in the patch-antenna case. For glass, it is usually assumed that its refractive index is ~1.5, giving a dielectric constant of ~ 2.25. This value is too low for a DRA to have good polarization purity. However, it was generally overlooked that this dielectric constant was obtained at optical frequencies instead of microwave frequencies. Recently, a dielectric constant of ~7 was measured for glass at 2 GHz and this value is sufficient for obtaining a good radiator. Since crystals are basically glass, they can also be used for antenna designs. In this talk, the characteristics of glass DRAs will be shown. In addition, the idea of using a 3D glass antenna as a light cover will be presented. It has been experimentally found that the lighting and antenna parts do not affect each other because they are operating in totally different frequency regions. Interesting results will be presented in this talk.

Finally, it will be shown that 3D transparent antennas can be designed as aesthetic glass (or crystal) wares or artworks. This idea is especially useful when invisible antennas are needed due to psychological reasons. The idea has been demonstrated successfully using a glass swan and a glass apple bought from the commercial market. The results will be presented in this talk.

BIOGRAPHY

Kwok Wa Leung was born in Hong Kong. He received the B.Sc. degree in Electronics and Ph.D. degree in electronic engineering from the Chinese University of Hong Kong, in 1990 and 1993, respectively.

From 1990 to 1993, he was a Graduate Assistant with the Department of Electronic Engineering, the Chinese University of Hong Kong. In 1994, he joined the Department of Electronic Engineering at City University of Hong Kong (CityU) and is currently a Professor and an Assistant Head of the Department. He is also the founding Director of the Innovation Centre of the Department. From Jan. to June, 2006, he was a Visiting Professor in the Department of Electrical Engineering, The Pennsylvania State University, USA.

Professor Leung was the Chairman of the IEEE AP/MTT Hong Kong Joint Chapter for the years of 2006 and 2007. He was the Chairman of the Technical Program Committee, 2008 Asia-Pacific Microwave Conference, Hong Kong, the Co-Chair of the Technical Program Committee, 2006 IEEE TENCON, Hong Kong, and the Finance Chair of PIERS 1997, Hong Kong. His research interests include RFID tag antennas, dielectric resonator antennas, microstrip antennas, wire antennas, guided wave theory, computational electromagnetics, and mobile communications. He was an Editor for HKIE Transactions, a Guest Editor of IET Microwaves, Antennas and Propagation, and an Associate Editor for IEEE Antennas and Wireless Propagation Letters. He was also an Associate Editor for IEEE Transactions on Antennas and Propagation and received Transactions Commendation Certificates twice in 2009 and 2010 for his exceptional performance. Currently, he is the Editor-in-Chief of IEEE Transactions on Antennas and Propagation. He is a Distinguished Lecturer of the IEEE Antennas and Propagation Society.

Professor Leung received the International Union of Radio Science (URSI) Young Scientists Awards in 1993 and 1995, awarded in Kyoto, Japan and St. Petersburg, Russia, respectively. He received CityU Research Excellence Award 2013 and Departmental Outstanding Teacher Awards in 2005, 2010, and 2011. He is a Fellow of IEEE and of Hong Kong Institute of Engineers (HKIE).