A Deformed Film UWB Antenna

#Ning Guan [1], Hiroiku Tayama [1], Hirotaka Furuya [1], David Delaune [1], Koichi Ito [2]
[1] Optics and Electronics Laboratory, Fujikura Ltd.
1440, Mutsuzaki, Sakura, 285-8550, Japan, guan@lab.fujikura.co.jp
[2] Faculty of Engineering, Chiba University
1-33, Yayoi-cho, Inage-ku, Chiba, 263-8522, Japan, ito.koichi@faculty.chiba-u.jp

1. Introduction

Recently, microwave ultra-wideband (UWB) technology has attracted much attention in high speed wireless communications, imaging and radar applications. Antennas with very wide impedance bandwidth and stable radiations are required for such systems. Among many UWB antennas, planar types are low profile, light weight, low cost and suitable for mobile devices [1]. However, the planar antennas may not radiate omni-directionally at all operating frequencies because they generally have wide structures and are not rotationally symmetrical. A roll monopole antenna which is constructed by twisting a planar radiator into a roll shape has been proposed for improving radiation characteristics, but the bandwidth of the antenna was limited [2].

In this paper, we will propose a deformed film UWB antenna for operating at the FCC approved UWB of 3.1-10.6 GHz. The antenna is constructed by deforming a planar dipole which has a glass-shaped radiation element [3]. The antenna is optimized for the UWB operation in its planar form and can be deformed by different manners such as folding, meandering or twisting, without much influence on input characteristics. The deformation not only miniaturizes the antenna but also improves its radiation characteristics.

To investigate experimentally the antenna, a prototype with a dimension of 20x33 mm^2 is fabricated and then the antenna is deformed by rolling into a circular rod with a diameter of 6.5 mm, or meandering it into a square rod with a cross-sectional dimension of 6x5 mm^2. It is demonstrated that the deformed antennas still operate at the UWB and have better omni-directional radiation patterns than the antenna in its planar form.

2. Antenna Configuration

2.1 Planar Form

Figure 1 shows the configuration of the proposed antenna in planar form which consists of a glass-shaped radiation element. In this element, a square outline is applied to the upper part for the effective use of the height of the element while an ellipsoidal outline is to the lower part for the purpose of bandwidth enhancement. An ellipsoidal hole and a square base are used for the same purpose.

Figure 2 shows the calculated input characteristics for antennas with different widths w of the base. It is shown that an appropriate w of 8 mm drastically broadens the bandwidth. However, the broadening effect decreases when w is too large because a long base cancels out the effect of the ellipsoidal outline.

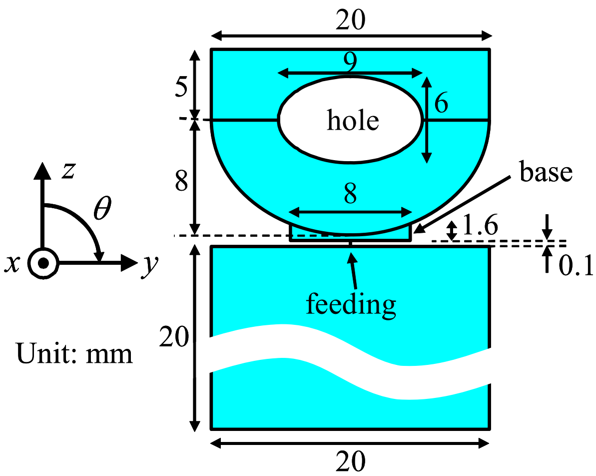

Figure 1: Configuration of antenna in planar form

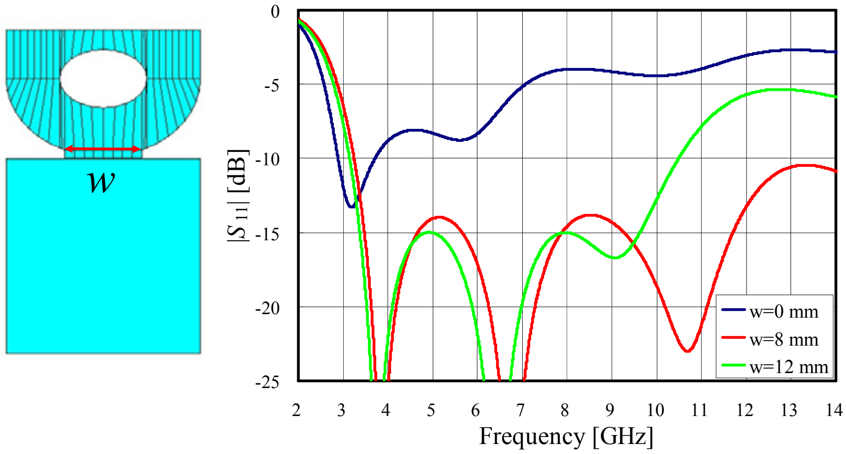

Figure 2: Calculated input characteristics for different widths of the base

2.2 Antenna Deformation

The planar antenna can be rolled or meandered, as shown in Fig. 3. The deformations minimize the planar antenna and do not seriously influence the input characteristics. Figure 4 shows the calculated input characteristics for the deformed antennas. It is shown that the deformed antennas maintain the UWB operation. Figure 5 shows the calculated radiation patterns in the *xy*-plane at 8 GHz for the different deformations. It is shown that the deformed antennas radiate more omni-directionally than the planar one.

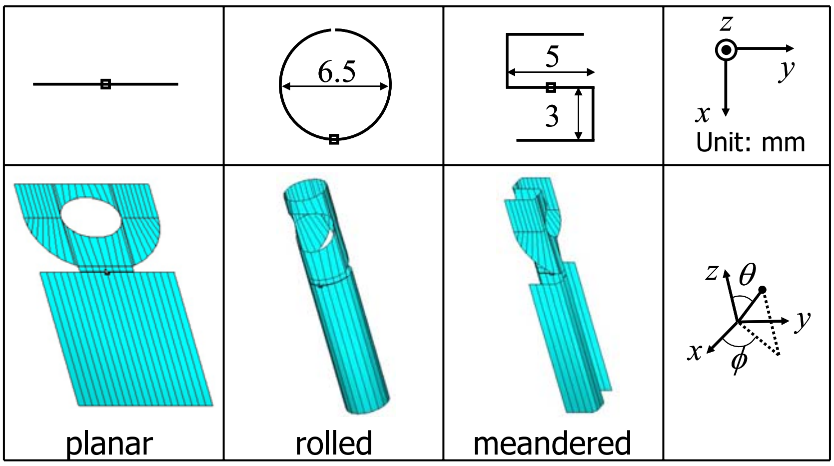

Figure 3: Deformations of planar antenna

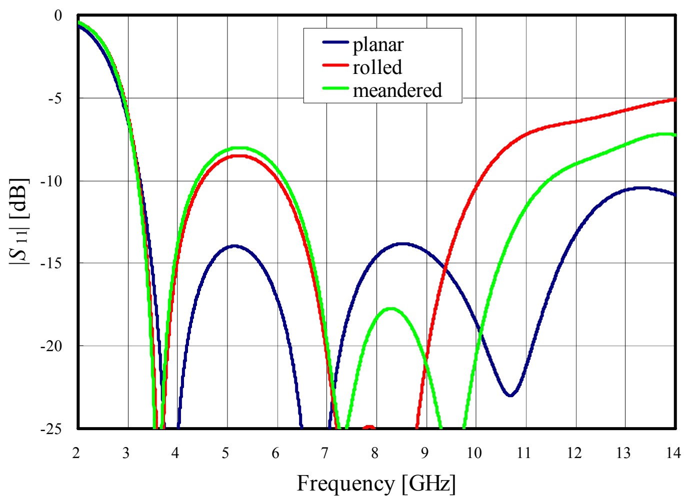

Figure 4: Calculated input characteristics for deformed antennas

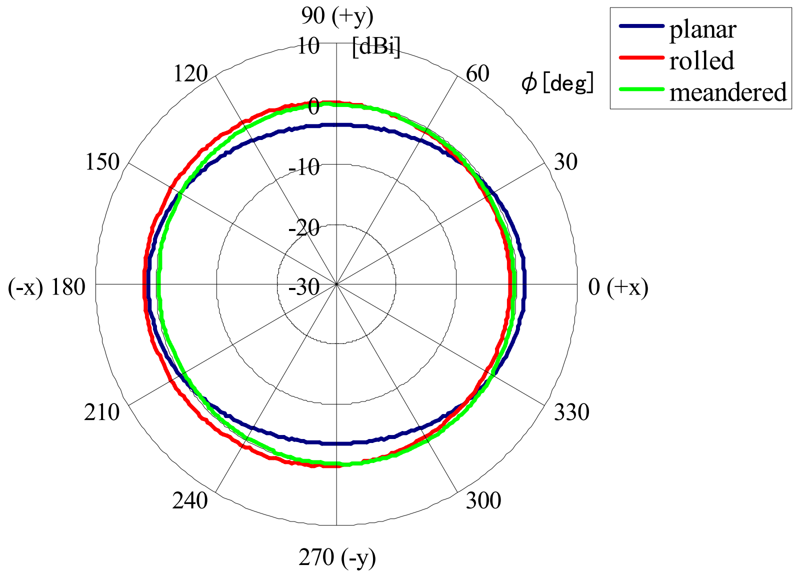

Figure 5: Calculated radiation patterns in the *xy*-plane at 8 GHz for deformed antennas

3. Experimental Results

To confirm the previous calculation results, an antenna is fabricated and deformed, as shown in Fig. 6. A coaxial cable with a diameter of 0.8 mm and a length of 50 mm is used for the feeding. Figure 7 shows the measured input characteristics. Although there is a little deterioration in the input characteristics, the deformed antennas can still perform an UWB operation, as expected. The deformations change the dimension of 20x33 mm^2 of the planar antenna to 6.5x6.5x33 mm^3 for the rolled one and to 6x5x33 mm^3 for the meandered one, respectively. The deformations make also the antenna radiate more omni-directionally, because the deformed antennas operate like a thin wire antenna and the currents on the antennas contribute constructively to the azimuthal radiation at the operating frequencies. Figure 8 shows the measured radiation patterns in *xy*-plane at 8 GHz and confirms this assumption. Ripples in the radiation patterns are due to the interference between the antenna and the feeding cable.

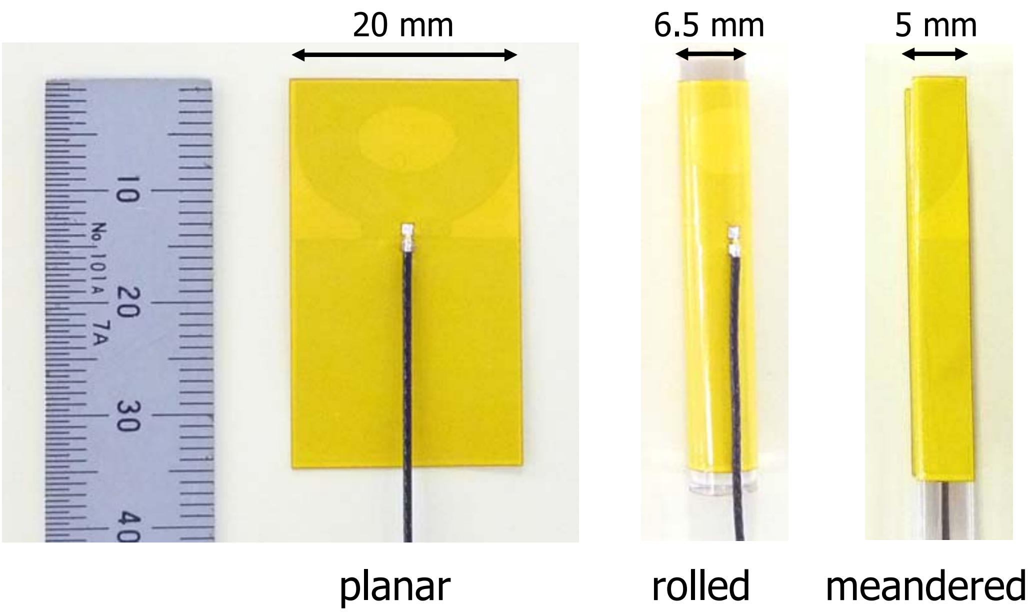

Figure 6: Fabricated antenna and its deformations

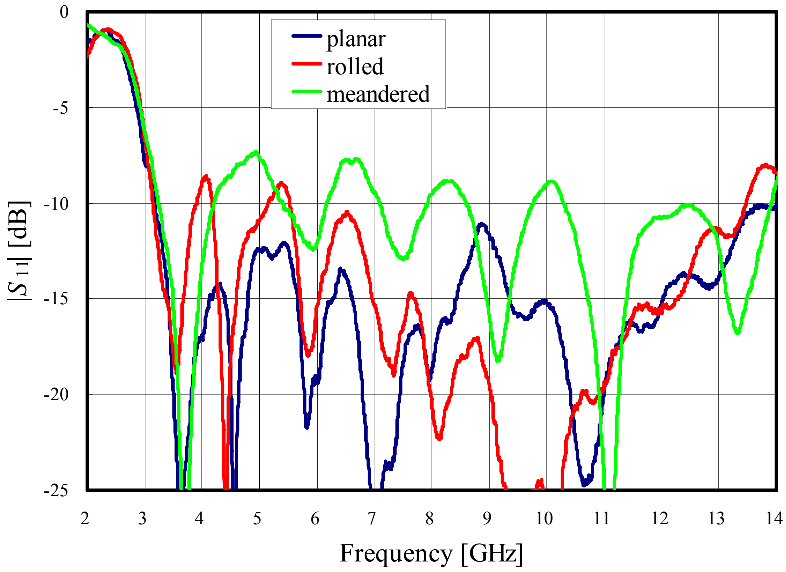

Figure 7: Measured input characteristics for deformed antennas

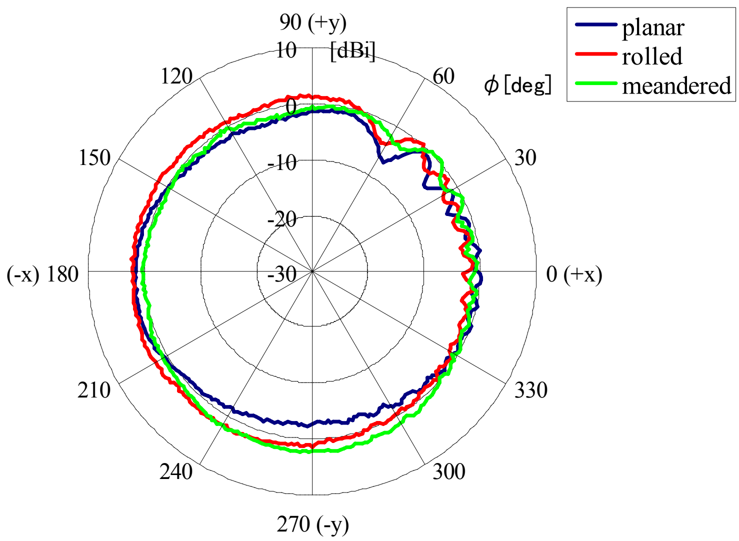

Figure 8: Measured radiation patterns in the *xy*-plane at 8 GHz for deformed antennas

4. Conclusion

We have proposed a deformed film antenna for operation at UWB. A planar antenna with a glass-shaped radiation element is rolled or meandered without much influence on the UWB operation. The deformations not only minimize the planar antenna but also improve the radiation pattern of the antenna. The deformed antennas can be easily installed into small mobile devices.

References

[1] Z.N. Chen, M.J. Ammann, X. Qing, X.H. Wu, T.S.P. See, and A. Cai, "Planar antennas," IEEE Microw. Mag., pp.63-73, Dec. 2006.
[2] Z.N. Chen, "Broadband roll monopole," IEEE Trans. Antennas Propagat., vol.51, no.11, pp.3175-3177, Nov. 2003.
[3] N. Guan, H. Tayama, T. Takino, and K. Ito, "A film UWB antenna with glass shape," IEICE General Conf., Matsuyama, Japan, B-1-178, Mar. 2009.