A Novel Design of Active Imidazolylquinoline Thin Film Organic Device Antenna

Shen Cherng[1], Anchi Yeh[2], Hsien-Chiao Teng[3]

[1]Department of Electrical Engineering, Chengshiu University, Niaosong, Kaohsiung, Taiwan, ROC 833
[2]Department of Chemical and Material Engineering and, Chengshiu University, Niaosong, Kaohsiung, Taiwan, ROC 833, scteng@mail.cma.edu.tw
[3]Department of Electrical Engineering, ROC Military Academy, Fengshan, Kaohsiung, Taiwan, ROC 830

Abstract: A novel design of the active NIQ/Cu thin film organic device antenna is demonstrated. The purpose of this antenna is applicable to study the promotion of the mobility of the electrons in organic device. [The Journal Of American Science. 2007;3(4):95-98]. (ISSN: 1545-1003).

Keywords: organic active device; mobility; imidazolylquinoline; antenna

I. Introduction

Recently, many designs of characterized organic devices including all types of organic light emission diode (OLED), organic thin film transistor (OTFT) have been reported [1, 2]. Modifying the organic complex and substrate can manoeuvre the characteristics of the device. Applying the technique of the fabrication of the planar organic device and the field measurement of the microstrip patch antenna, NIQ/Cu thin film component on the FR4 substrate can be function as a patch antenna with active organic device (OD) to express special characteristic of the device. Based on the shifting of the operation frequency of the active NIQ/Cu OD antenna in comparison with the micropstrip patch antenna resonated at TM_{11} mode, the dielectric coefficient and the carrier mobility of the carriers in device can be revealed by basic analysis. A simple geometry thin film active NIQ/Cu OD antenna was designed for the S-band at 2.4GHz and presented in this letter. Setting a truncated NIQ/Cu thin film patch OD at 1000/2000 nm (NIQ/Cu) in thickness is for the consideration of circular polarized field transmitted from the patch of NIQ/Cu, which may promote the mobility of the hop electrons at a specific direction provided by NIQ thin film as well as the conduction electrons from the copper [3].

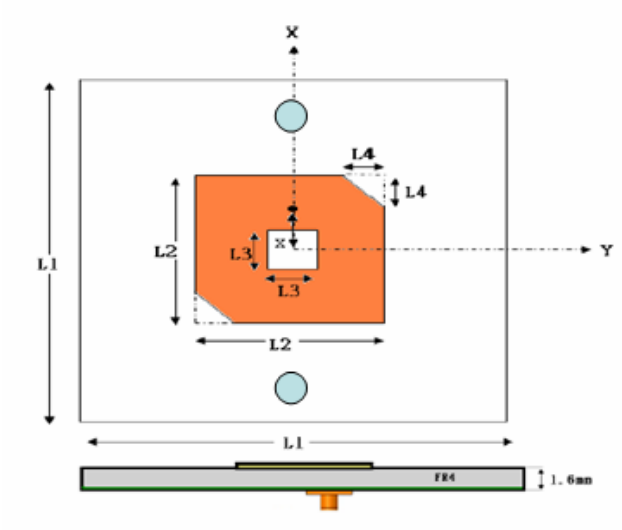
II. Design of the device

An architectural schematic drawing of the truncated 2000 nm thick rectangular cooper patch with depositing 1000nm dielectric organic thin film NIQ is depicted in Figure 1 where the probe-feeding is at distance of 5.1mm to the centre of the patch. Meanwhile, the thickness of the substrate is 1.6mm. SMA connector with characteristic impedance Z_o (50 Ω), loss tangent (tangentδ) and specific ε_r (4.4) for inexpensive FR4 substrate shown in the figure are regarded as major parameters in transmission line model (the size of ground is assumed infinite).

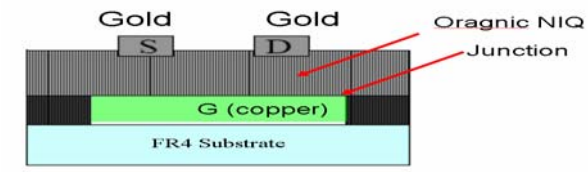
Refer to the reference [3], the mobility of the electrons and the loss tangent of the patch NIQ/Cu OD were calculated and listed in Table 2.

Table 1. Design parameters of the NIQ/Cu patch OD

Substrate	FR4 (1.6 mm)
Patch	NIQ/Cu 1000/2000 nm
Ground	35×35 mm² 10mm margin
L1	45 mm
L2	28 mm
L3	8 mm
L4	4.4mm
X	5.1mm



(a) top and front view



(b) side view

Figure 1. Schematic geometry drawing of the active NIQ/Cu OD antenna

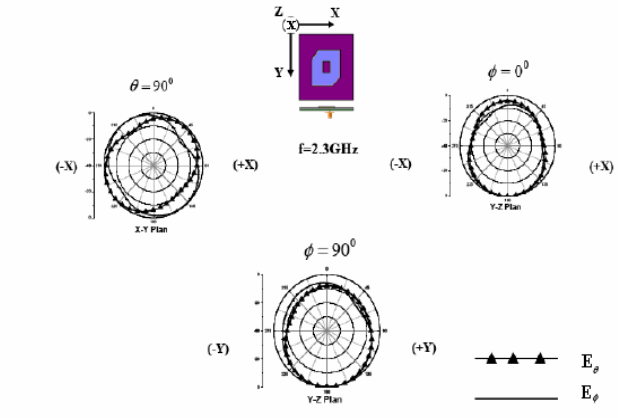


Figure 2. Field measurements of the proposed OD antenna with NIQ/Cu patch on FR4 substrate at thickness of 1.6mm

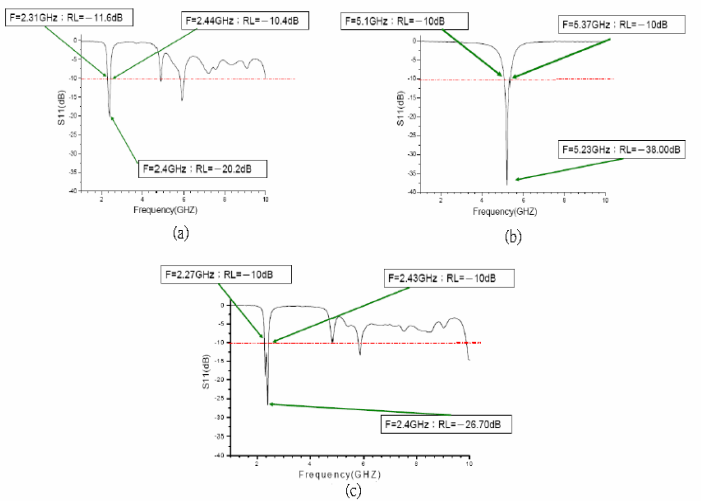


Figure 3. Measurement of the Return Loss of the OD antenna (a) only with patch of cooper (b) with the NIQ (c) with the NIQ/Cu.

Table 2. Results of the Calculation

Effective dielectric constant of NIQ (1000 nm thick)	0.96
Loss tangent of the NIQ/Cu (1000/2000 nm thick)	10^{8}
Loss tangent of the NIQ (1000nm thick)	10^{-4}
Electron Mobility in NIQ (1000nm thick) m^2/Vs	10^{-4}
Electron Mobility in NIQ/Cu (1000/2000 nm thick) m^2/Vs	10^{4}

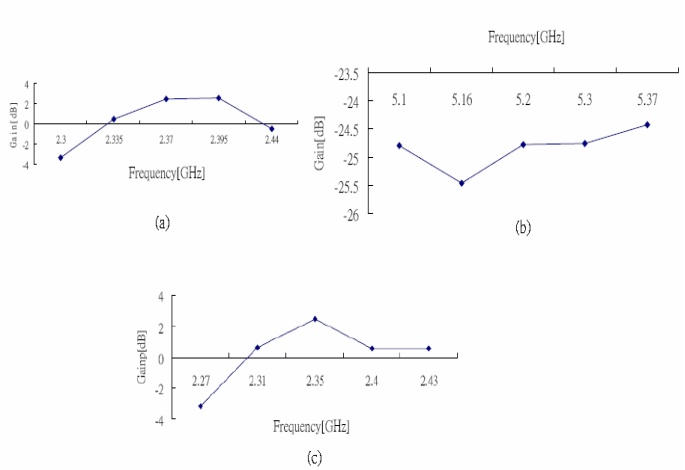


Figure 4. Measurement of the Gain of the OD antenna. (a) only with patch of cooper (b) with the NIQ (c) with the patch of NIQ/Cu.

Figure 4 depicts the measurement of the radiation gain of the active NIQ/Cu OD antenna [4].

II. Calculation Results and Conclusion

An active electronic material, 2-(naphtho[3,4]imidazol-2-yl) quinoline (NIQ), 1, has been synthesized and fully characterized [5]. This compound exhibits field-effect carrier mobility and behaves as a p-type semiconductor (mobility coefficient $\mu = 0.148\times10^{-4}$ m^2/Vs at $V_{DS} = 10$ V). NIQ and its related imidazolylquinoline compounds may have possible applications as active materials in organic thin film active OD antenna.The calculation has shown the loss tangent of NIQ is 10^{-4} and the dielectric coefficient is 0.94 for the NIQ thin film. Those values are patch OD thickness related. In contrast, as we know hop electrons affect the displacement current in OD, since displacement and the conduction current is up to 10^{+8} for the NIQ/Cu active OD antenna, the conduction current is dominated and shall be regarded as the major parameter controlling the characteristics of the OD. Moreover, for the radiation efficiency (gain) is highly related to the loss tangent and the dielectric coefficient, the organic active device can be used as the modulator of the microstrip antenna.

Correspondence to:
Hsien-Chiao Teng
Assistant Professor
Department of Electrical Engineering
ROC Military Academy
scteng@mail.cma.edu.tw
Telephone: 88677479510

REFERENCES

[1] (a) Horowitz, G.;Hajlaoui, R.;Bourguiga, R.;Hajlaoui, M. Synth. Met. 1999, 101, 401; (b) Guillaud, G.; Chaabane, B. R.;Jouve, C.;Gamoudi, M. Thin Solid Films 1995, 258, 279; (c) Lin, Y.-Y.;Gundlach, D. J.;Nelson, S. F.;Jackson, T. N. IEEE Trans. Electron Dev. 1997, 44, 1325.

[2] Alexandre Vial and Thierry Laroche **"**Description of dispersion properties of metals by means of the critical pointsmodel and application to the study of resonant structures using the FDTD method" J. Phys. D: Appl. Phys. 40 (2007) 7152–7158

[3] Pankaj Kumar, S C Jain, Vikram Kumar, Suresh Chand, M N Kamalasanan and R P Tandon "Study of electron mobility in small molecular SAlq by transient electroluminescence method" J. Phys. D: Appl. Phys. **40** (2007) 7313–7317

[4] KL Wong, Planar antennas for wireless communications, Chapter 5~7, John Wiley & Sons, New York, NY.2003

[5] Tsun-Ren Chen,Anchi Yehb and Jhy-Der Chen "A new imidazolylquinoline for organic thin film transistor", Tetrahedron Letters 46 (2005) 1569–1571