Thin Solid Films 521 (2012) 34–37

Contents lists available at SciVerse ScienceDirect

Thin Solid Films

journal homepage: www.elsevier.com/locate/tsf

Electron number and electron temperature evolution in the initial discharge phase of a shadow mask plasma display panel

Panpan Zhang, Yan Tu *, Harm Tolner, Lanlan Yang

Display R&D center, School of Electronic Science and Engineering, Southeast University, Sipailou 2#, Nanjing, China, 210096

ARTICLE INFO

Available online 27 March 2012

Keywords:
Electron number
Electron temperature
Simulation

ABSTRACT

During the initial discharge phase of a shadow mask display panel (SM-PDP), the time evolution of the number of electrons and electron temperature were investigated by simulation. Their dependence on the Xe concentration, dielectric layer and rise time of the driving voltage were analyzed, respectively. The results, indicating the temporal variation of both the number of electrons and the electron temperature, are of great importance in understanding the discharge process and characteristics of PDPs and can be used as guide lines to achieve higher luminous efficacy in the SM-PDP. A dielectric layer thickness of 30 μm and a dielectric constant of 10 or less, together with a reduction of the voltage rise time below 250 ns are found to be optimum for high efficacy.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

Improvement of the efficiency of the Plasma Display Panel (PDP) is a key issue for further expansion of the PDP technology [1]. International energy standards require that the total energy consumption of a 42-inch television (TV) is less than 81 Watt, while for 50-inch and higher it has to be below 108 Watt [2]. This is a reduction of about a factor of 2 compared with commercial models today.

In addition, in all cases referred to above, a thorough understanding of the discharge phenomenon in the PDP cell is indispensable in increasing the efficiency. Therefore, a deep investigation into the basic feature of the PDPs is important, in order to find design guidelines for further improvement.

Of all the PDP parameters, the number of electrons per discharge pulse and the electron temperature are fundamental ones, determining the discharge characteristics of the plasma. The vacuum ultraviolet (VUV) emissions from excited Xe^* resonant atoms and Xe_2^* dimers in Xe plasma diluted with He and Ne are dependent upon the plasma electron density and the electron temperature [3]. The electron number represents the discharge intensity, while the electron temperature is closely related to the VUV emission. The panel luminance is improved by an increase in the number of electrons per pulse. The reduction in electron temperature means a higher Xe excitation efficiency and an improved VUV photon generation efficiency [4,5]. It is believed that the lack of information on the electron temperature development is one of the factors preventing the realization of high luminous efficiency in PDPs. Therefore, a thorough investigation into both the number of electrons per discharge pulse and the electron temperature is important in obtaining guiding principles that will help improve the PDP performance.

The electron temperature has been determined in the past experimentally by determining the propagation speed of the cathode plasma in an AC-PDP. Values of 1.2 eV and 2.5 eV were found at driving frequency of 50 kHz and 100 kHz, respectively [6]. Similar results showed up using the micro-Langmuir probe method together with an intensified charge coupled device (ICCD) camera [7]. However, due to the small size of a PDP cell and short discharge periodic, all the values were estimated by averaging over a certain time span [8,9]. Therefore, it was difficult to discriminate experimentally how the electron temperature varies with time.

In this simulation on the other hand, by tracking all the particles in the structure, it was possible to trace the variation of the electron temperature during the discharge process. In this work the temporal evolution of both the number of electrons and the electron temperature were calculated during the initial discharge in a Shadow Mask PDP (SM-PDP) [10], as a function of xenon content, dielectric layer constant and voltage rise time.

2. Simulation structure and model

SM-PDP is an opposed type of plasma discharge display, as shown in Fig. 1 (a). The main difference with a classical opposed discharge PDP's is that the phosphor layer is deposited on the surface of the metal shadow mask, so that it cannot be damaged by the discharge plasma. Compared to the standard PDP configuration, using a planar type of discharge along the MgO surface, the firing voltage in an opposed discharge is much smaller [11].

* Corresponding author. Tel.: +86 25 83792449 801; fax: +86 25 83363222.
E-mail address: tuyan@seu.edu.cn (Y. Tu).

0040-6090/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.tsf.2012.03.077

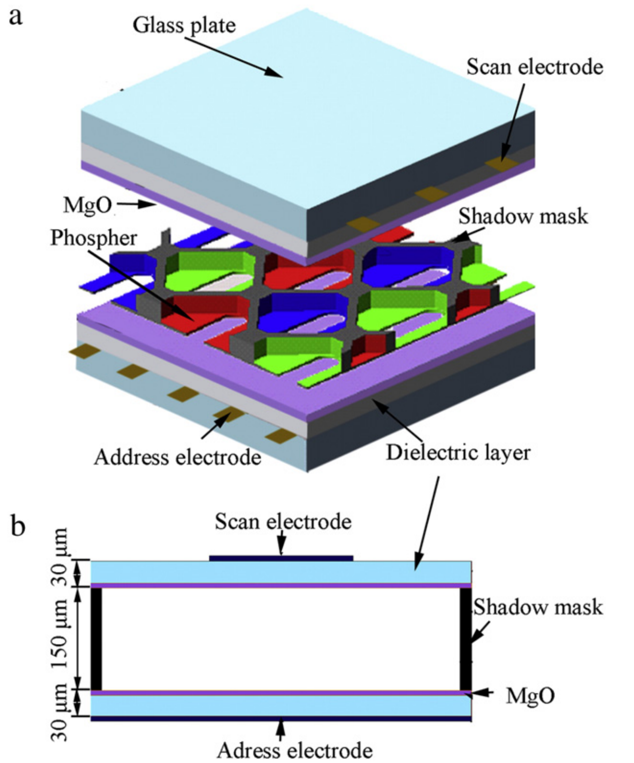

Fig. 1. (a) Schematic diagram of the SM-PDP. In the simulation, a cell is modeled in two dimensions as shown in (b).

In order to further optimize the SM-PDP performance, we used Object Oriented Particle In Cell (OOPIC), a 2 dimensional (2D) Monte Carlo collision particle in cell simulation software [12,13], to calculate the optimum conditions in terms of xenon content, dielectric layer constant and sustain voltage rise time. The simulation using OOPIC is rather time consuming, and therefore the structure was simplified into a 2D cell as presented in Fig. 1 (b). It is noted that both front and rear plate glass were neglected and the thickness of the MgO layer was set to be negligible. Other discharge conditions adopted were as follows unless stated otherwise. As indicated in the figure, the width and height of the cell were 1080 μm and 210 μm, respectively, and the gap between dielectric layers, determined by the metal shadow mask was 150 μm. The thickness and relative permittivity of the upper and lower dielectrics were 30 μm and 10. The gas mixture filled into the panel is Xe/Ne(10%/90%), and the pressure in this study was 4000 Pa. Although the thickness of the MgO and phosphor layer was neglected in the simulation, the discharge characteristics of the MgO and phosphor layer were, of

Table 1
Parameters for the fitted curve $N = N_0 e^{-t/\tau}$.

	N_0	τ(μs)	Adj. R-square
x (%)			
10	1.276e12	0.7536	0.9996
20	1.132e12	0.7692	0.9994
30	1.0983e12	0.7764	0.9990
d (μm)			
20	1.854e12	0.7553	0.9996
30	1.276e12	0.7536	0.9996
40	9.634e11	0.7491	0.9997
ε_r			
8	1.023e12	0.7527	0.9998
10	1.276e12	0.7536	0.9996
12	1.520e12	0.7537	0.9995
t_r (ns)			
0	1.276e12	0.7536	0.9996
250	8.653e11	0.7220	0.9994
500	7.062e11	0.4096	0.9810

N is the electron number at time t; N_0 is the maximum electron number in each cell. The fitted decay time τ is listed in the table.

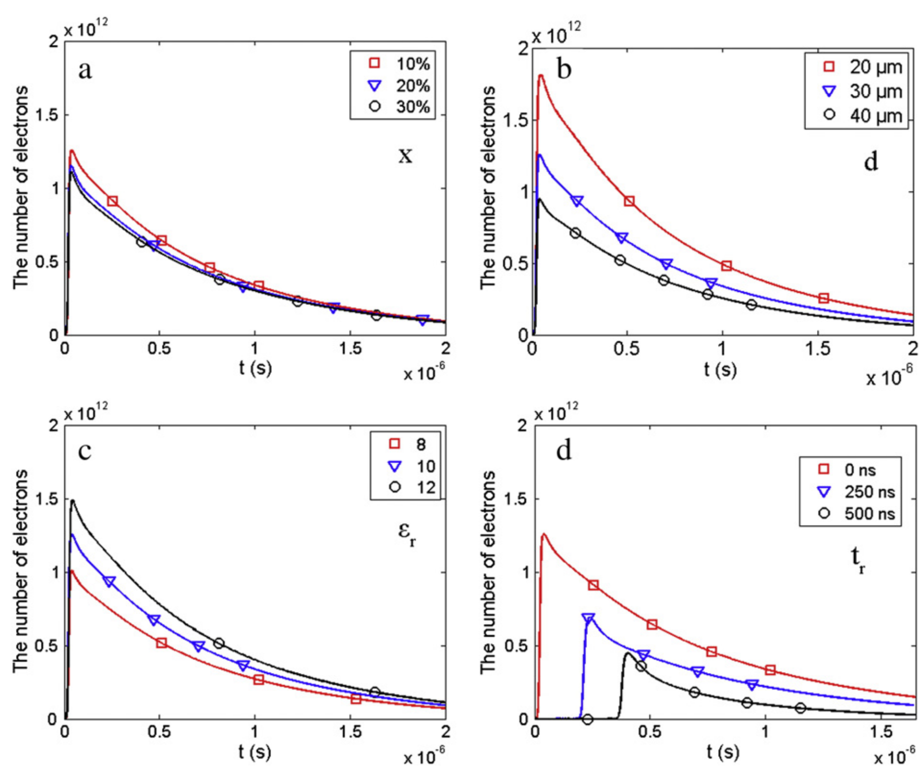

Fig. 2. Temporal evolution of the number of electrons for different Xe concentration x, dielectric layer thickness d, relative permittivity ε_r, and voltage rise time t_r.Note: Fig. 2 (a) shows the effect of different x values (10%, 20% and 30%), when d = 30 μm, ε_r = 10, t_r = 0 ns. (b) different dielectric layer thickness d (20 μm, 30 μm, and 40 μm) when x = 10%, ε_r = 10, t_r = 0 ns, (c) different dielectric constant ε_r (8,10,12) x = 10%, d = 30 μm, t_r = 0 ns and (d) different t_r (0, 250 ns, 500 ns), when x = 10%, d = 30 μm, ε_r = 10. The operating voltage in all cases is 360 V.

Download English Version:

https://daneshyari.com/en/article/1666920

Download Persian Version:

https://daneshyari.com/article/1666920

Daneshyari.com