A Case Study of Fabrication of Film with Spark Technique

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***Abstract*- The purpose of this research was to the fabrication of ITO thin film was using the spark technique with high voltage on silicon wafer substrate. In order to confirm the ITO surface on silicon wafer substrate, the film was investigated of surface morphology with SEM/EDS. The spark method for fabrication of film was using 10 V of spark voltage, 10 kHz of frequency and 30 minutes of spark time. The sample was annealed difference at 250□C at 180, 240 and 300 minutes. The ITO thin film confirms the formation of ITO thin film on the substrate with result from SEM/EDS. In addition, when the long time annealed as a result of the ITO thin film was better film from a uniform of surface.**

I. INTRODUCTION

At present, thin films are widely used because of interesting features and it is new material technology. Indium tin oxide (ITO) thin films are n-type, degenerate semiconductors with wide band-gap with a good electrical conductivity, high transmittance, excellent substrate adherence and widely used as transparent in the visible range [1]. Due to these characteristics, ITO films are widely used for many applications such as organic light-emitting diodes (OLEDs), liquid crystal displays (LCDs), solar cells, etc

ITO thin film have been obtained by various techniques, such as chemical vapor deposition [2], RF-magnetron sputtering [3], spray pyrolysis [4], pulsed laser deposition [5], sol–gel-dip-coating [6]. But, these methods are a lot of cost for fabrication. On the other hand, the thin film fabrication with spark technique is technology for fabrication thin film [7] on low cost. In this paper, the fabrication of ITO thin film was using the spark technique with high voltage on silicon wafer substrate. In addition, the ITO thin film was investigated of surface morphology with SEM/EDS.

II. EXPERIMENTAL SETUP

The fabrication of thin film with Spark technique consists of 3 important parts, Rectifier circuit, Spark control circuit and High voltage generation which can generate voltage 1-10 kV and frequency 1-10 kHz, as shown in Fig 1.

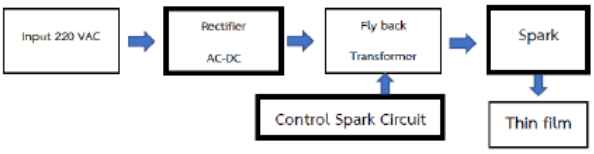

Fig. 1. Block diagram of the fabrication of thin film with Spark technique

The rectifier circuit was convert AC voltage to DC voltage at 0-20 VDC from 0-220 V of the variac transformer on input side.

Fig 2 shows the spark control circuit which pulse width modulation (PWM) was generated from high frequency of IC-TL494 for controlling the switching of the device. In addition, the IGBT-IRG4PC50UD is used for switching to the TLF14511F of flyback transformers.

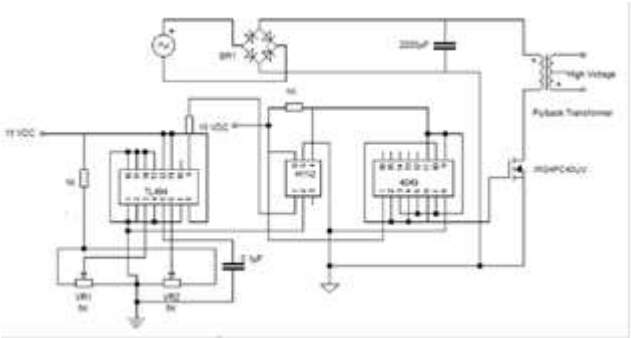

Fig. 2. The Spark control circuit

Fig 3 shows complete circuit from the designed which the frequency of the switch and high voltage can be adjusted from 0-20 kHz. and 5-20kV. respectively.

Fig 4 shows the thin film fabrication with spark technique which output terminal has been separate to 2 sets for Indium wire and tin wire while the positive electrode and ground electrode has been spaced at 2 mm. The vapor from the spark technique was fall to below as results in the deposition to film on silicon

wafer substrate

Fig 3. complete circuit of the thin film fabrication with spark technique

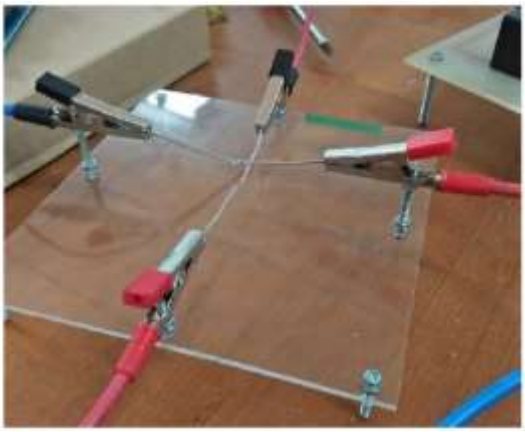

Fig 4. the connect Indium wire and tin wire for spark technique

The conditions of this research for fabrication of film were using 10 V of spark voltage and time at 30 minutes of spark. After that, the sample was annealed at 250□C at 180, 240 and 300 minutes. The morphology of the ITO thin film has been investigated by SEM/EDS of JEOL model SM-6610LV for different condition of the time annealed.

III. RESULTS AND DISCUSSION

Fig 5 shows an image of the ITO surface on silicon wafer substrate from SEM with x1000 of magnification from spark voltage at 10 V for thin film fabrication with spark technique when of annealed at 250 C temperature and 180 minutes. It was found that, the surface is not a film texture due to the vapor of indium and tin has spread with patches. Besides, the vapor of indium and tin on the silicon wafer has not connection with completely. It was confirmed that, the annealed with temperature at 250C and time 180 minutes cannot fabrication of ITO thin film due to the annealed has short time which may not affect the microstructure.

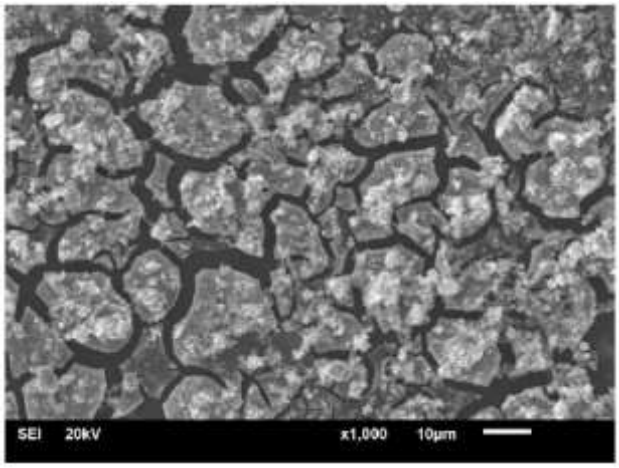

Fig. 2. the EER and the COP. of the air conditioner by Blynk Application

Fig 6 shows an image of the ITO surface on silicon wafer substrate when time annealed at 240 minutes with same conditions as Fig 5. It was found that, the surface was begin a film texture with some connect of vapor of indium and tin on the silicon wafer substrate. On the other hand, the connection of the Indium and tin vapor was not uniform throughout the substrate which some area still had the surface of silicon wafer substrate. It was confirmed that, the annealed with temperature at 250C and time 240 minutes can be fabrication of ITO thin film. However, this ITO thin film still had a very defect from the vacancy between thin film and substrate.

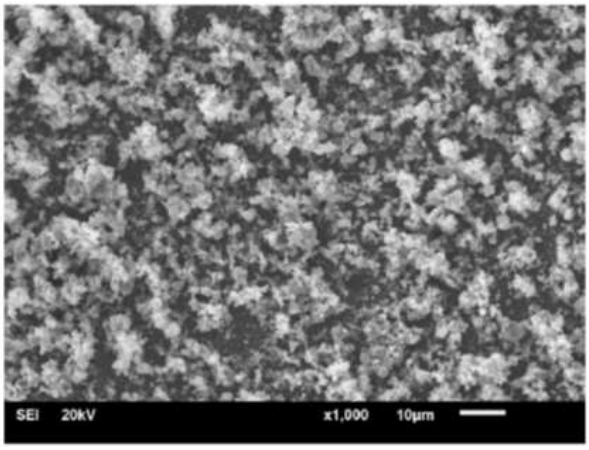

Fig. 6. EER of air conditioners by comparing and comparing the actual measure and Blynk application.

Fig 7 shows an image of the ITO surface on silicon wafer substrate when time annealed at 300 minutes with same conditions as Fig 5. It was found that, the surface was morphology with a uniform appearance throughout the surface as a result of a long time of annealed and the good deposition of indium vapor and tin vapor. Consequently, it was confirmed that the ITO thin film can be fabrication from spark technique which using

annealed as co-step with more than 300 minutes.

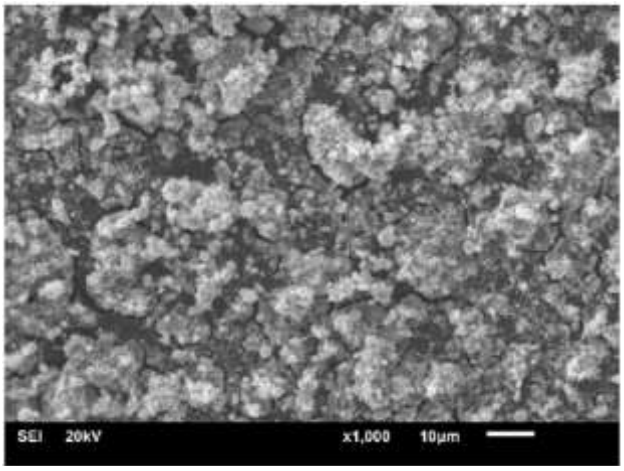

Fig 7. the ITO surface on silicon wafer substrate when 300 minutes of annealed

Fig 8 shows the quantity of elements on the ITO film with silicon wafer substrate from EDS analysis of scanning technical. It was found that, the silicon show most quantity due to silicon wafer was substrate. However, the quantity of elements of indium and tin with EDS analysis was 1.86% and 0.58%, respectively. Consequently, it was confirmed that the ITO thin film can be fabrication from spark technique with using annealed as co-step.

Element	Weight%	Atomic%
C K	6.91	14.02
N K	3.71	6.46
O K	34.75	22.44
Si K	65.03	74.64
In L	8.76	1.86
Sn L	2.84	0.58
Totals	100.00	

Fig 8. The quantity of elements on the ITO film from EDS analysis

IV. CONCLUSIONS

The preparation of ITO thin film was successfully performed by high-voltage spark technique with using indium wire and tin wire for spark which vapor of indium and tin was fall into silicon wafer substrate. Besides, in this paper was studied of ITO thin film morphology from time annealed in different when the voltage and frequency for spark was 10 V and 10 kHz, respectively. It was confirmed that, the ITO thin film can be fabrication from spark technique with using annealed as co-step with results were investigated by SEM/EDS. Especially, when time of annealed more than 300 minutes as a result in the thin film was more uniform and linked between the vapor of indium and tin on the surface substrate. However, the amount of indium and tin from fabrication with spark technique has lass of percentage when using EDS analysis, thus the fabrication by spark technique must be developed in the future.

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