Optik 158 (2018) 1470–1477

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

Original research article

Study a scanning beam current in focusing ion beam device of overcome mirror effect

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ARTICLE INFO

Article history:
Received 24 December 2017
Accepted 15 January 2018

Keywords:
Ion optics
Focusing ion beam device
Ion beam current
Ion mirror effect
Insulator charging

ABSTRACT

The present work adopted mathematical model used to study the effect the electron beam current on the electron-mirror images. This mathematical model employed to study the characteristics polymer PMMA a through ion mirror effect phenomenon. The results show it is possible to use this model to study an ion mirror effect phenomenon and an electron mirror effect phenomenon alike. Results demonstrated that best understand and interpret for the physical behaviors of a scanning ion may be extracted. Hence can be finding energy safer, which can be used without damage to the sample under study and also can be calculating the required current to reach the surface of the sample for each scanning potential. Furthermore, the mathematical model shows an ability to produce a method for calculating the trapped charge and the maximum stopping potential to disappear the ion mirror effect and accurately excellent.

1. Introduction

The term Ëlectron opticsör Ïon opticsäre defined as the branch of physics that deals with matters related to the motion of particles charged by magnetic fields and electric fields, and the generation of images using electron beams or ion beams [1,2]. Today's optical electronic devices have become analytical devices that are indispensable in many technology fields. Although the age is short for scientific development, these devices have undergone great development and mutations in a short period of time [3].

That the first and simplest application of electronic optics is the construction of the Scanning Electron Microscope (SEM). The advanced applications of the charged particles are the instrument Focus Ion Beam (FIB) [4,5].

The understanding of the mechanism of accumulation of charges in insulation materials is very important in science and modern technology because it leads to best applications of insulation materials, especially in the fields of electronics and space technology [6,7]. The scanning electron microscope (SEM) and the instrument Focus Ion Beam (FIB) are among the most important devices used in the accumulation of charges because it provides the possibility of controlling the number of the charge orient towards the insulation and the area in which it is distributed, in addition to controlling the charges conditions different.

The Focus Ion Beam instrument (FIB) is one of the most important devices currently used in nanometer scale applications [8,9]. The Focus Ion Beam instrument (FIB) is similar to Scanning Electron Microscope (SEM), and the fundamental difference to both is the nature of the beam used in scan. In the Focus Ion Beam instrument (FIB) from ions and often Gallium ion Ga^+,

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https://doi.org/10.1016/j.ijleo.2018.01.051
0030-4026/

Table 1
A comparison between device (FIB) and device (SEM) device [10].

Particle	FIB	SEM	Ratio
Type	Ga ion	Electron	
Elementary charge	+1	−1	
Particle size	0.2nm	0.00001 nm	20000
Mass	1.2×10^{-23} kg	9.1×10^{-31} kg	130000
Velocity at 30 kV	2.8×10^{5} m/s	1.0×10^{8} m/s	0.0028
Momentum at 30 kV	3.4×10^{-20} kg m/s	9.1×10^{-23} kg m/s	370
Penetration depth in polymer at 30 kV	60 nm	12000 nm	0.005
Average signal per 100 particles at 2okV			
Secondary electrons	100–200	50–75	1.33–4.0
Backscattered electron	0	3050	0

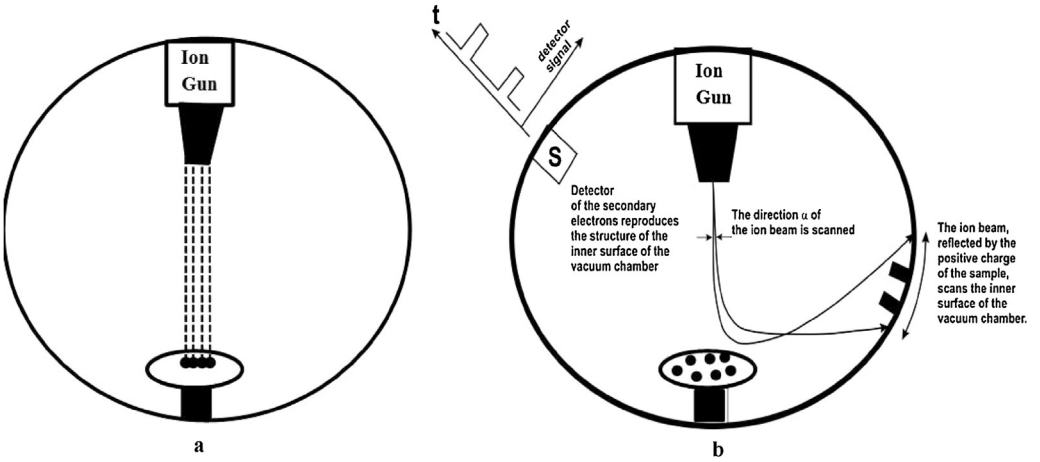

Fig. 1. (a) A schematic diagram revealing charging the insulating surface (forming a layer of ions on the sample surface (charge trapping)). (b) A schematic diagram revealing the Ion Mirror Effect (IME) phenomena [15].

the beam ion (FIB) can be emitted to a diameter equivalent to the fraction of nanometer. As a result, the accuracy obtained by FIB is better than SEM and the interaction of the Gallium ion Ga + to the target material varies on interaction of electrons with the same material and Table 1 shows a comparison between (FIB) and (SEM) [10].

The electron mirroring effect (EME) occurs in scanning electron microscope (SEM) has been notified since the 1970s [11,12]. In 2008, a similar effect observed in focusing ion beam (FIB) by Croccolo and Riccardi, it is called Ion mirror effect [13]. Since then, great effort has been to make sure the electron mirror effect and ion mirror effect does not occur. Recently, it turns out that the electron mirror effect and ion mirror effect is quite useful and use it as a tool to obtain information about the model dielectric materials properties or use it as an analytical tool in the SEM and FIB systems [14].

2. Theoretical aspects

2.1. Mirror effect phenomenon

mirror effect phenomenon is occurring inside the chamber of the scanning electron microscope (SEM) or inside the chamber of the focus ion beam instrument (FIB) in a non-conductive sample when the irradiated by electrons or ions, an excess charge is spatially trapped within the sample generating distortions in the electrons or ions beam path, leads to image the insider chamber space instead of imaging the sample surface[13]. The imaging ion mirror effect (IME) is the result of a two-step process (see Fig. 1).

2.1.0.1. First step

The first step is the charging the insulating surface until it acts as an ion mirror of sufficient strength to deflect the ions of the primary beam towards the secondary electron detector (i.e., forming a layer of ions on the sample surface (charge trapping)) (see Fig. 1a).

When the focusing ion beam is used as a source energetic ion, the disc charge area is produced. A disc of radius R_s with amount positive charge trapping Q_t on the surface sample (see Fig. 2a).