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Novel Silicon Nanowire-based Electron Detector Utilized in Next Generation Scanning Electron Microscopes

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Electron microscopes are the scientific tools which utilize highly energetic electron beam (up to 40 keV) to overcome the light limitations in the study of specimen in nm scale. Since its invention, Electron microscope has been a valuable tool in the development of scientific theories and it has been contributed in many fields of science such as nanoelectronics, material engineering, biology, medicine and surface engineering [1].

Electron detection has an important role in microscopic analysis and known as one of the most important blocks of SEM. The conventional Everhart-Thornley (E-T) detector utilized optical approach, consists of scintillator, maintained at 12 kV positive potential to attract the incoming electrons from the specimen, light tube, photomultiplier and amplifier [2]. The photons generated due to the interaction of incoming electrons with the scintillator surface travels through a light tube toward the photomultiplier (PMT) block. The signal generated at the output of the detector is due to the light stimulated current which amplified by PMT [3]. Due to optical instruments used in construction of the detector, it is a large sophisticated device which cannot close to the specimen.The positive or negative potential relative to the source of the electrons helps it to attract electrons [4]. For getting more resolution and contrast, it's better to close the detector to the specimen to collect more electrons.

Here, our novel electron detector is a miniaturized nano-structured device which can be approached to the specimen (fig. 1). This detector attracts electrons along with converting their current to voltage directly. The current was measured by a low noise and precise picoammeter. It was fabricated by growing silicon nanowires (SiNWs) on a p-type silicon substrate covered by gold in a VLS process (fig. 2). Gold was used as the catalyst layer for NW growing. The SiNWs with the diameter less than 70 nm along with Si substrate were highly doped to act as nm electron sensitive conductive wires (fig 3a, 3b). The ultra-low cost, high voltage free, simply fabricated nano-structured detector which eliminates the optical phase from the electron detection process enhances the yield of electron detection in a highly manner.

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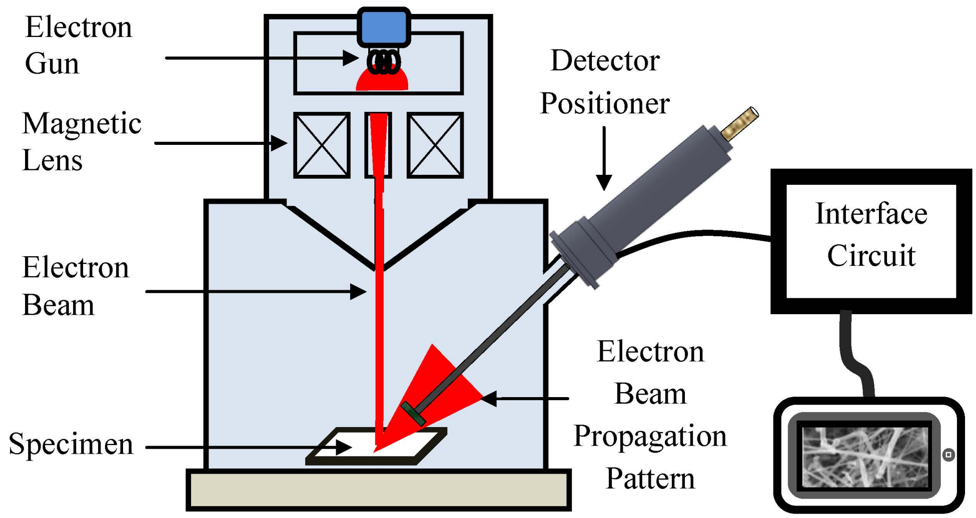

Figure1. Miniaturized nano-structured electron detector located on the detector positioner.

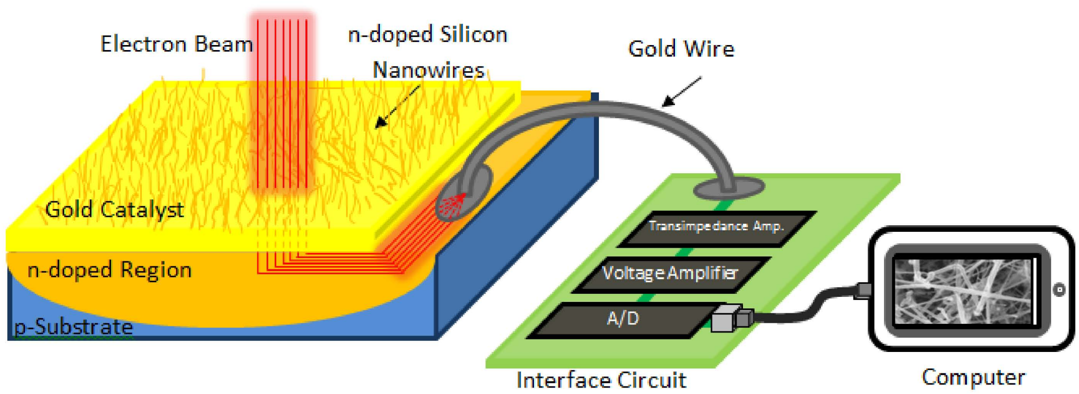

Figure2. Silicon nanowires (SiNWs) on a p-type silicon substrate covered by gold layer as a electron detection system.

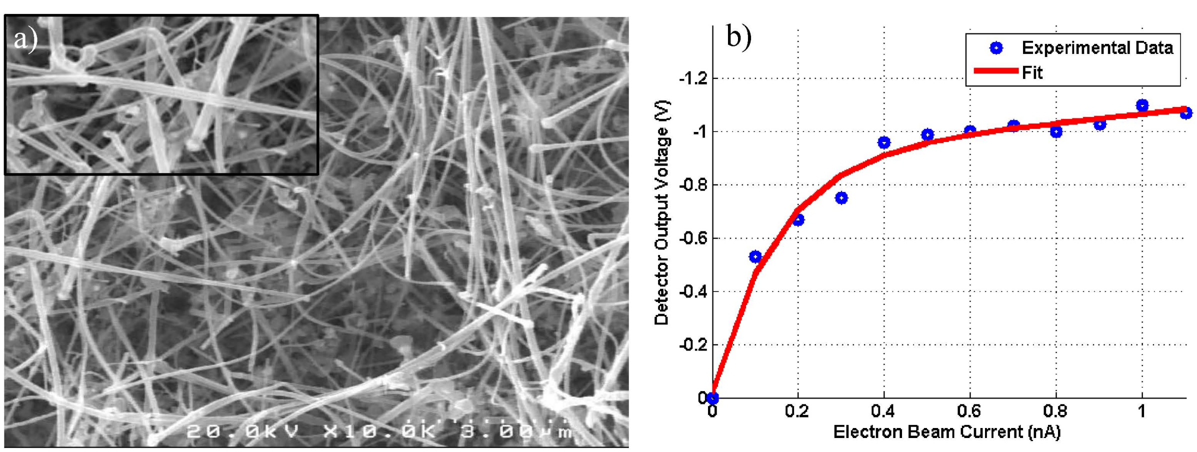

Figure3. a) The SiNWs act as nm electron sensitive conductive wires, b) detector output voltage versus electron beam current.

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