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Development of Crystal Lattice Defect Direct Viewing Instruments

Silicon crystal is indispensable as a substrate material for integrated circuit LSI and semiconductor devices. In order to improve the crystal quality, a crystal evaluation method has been required to determine how crystals containing no dislocation grow. J. Chikawa et al., actively worked on the development of the method to examine the behavior of defects of this dislocation-free crystal. First, they started upgrading the intensity of X-rays, the light source of X-ray diffraction microscopes. As a result, they developed a high-intensity spinning target X-ray generator. In addition, they manufactured a new image pick-up tube by way of trial -—setting the oxide photoelectric surface in lead so as to make an image pick-up tube for visible light sufficiently sensitive to the X-ray range. Eventually, they succeeded in being the first in the world to develop a crystal lattice defect direct viewing instrument—being able to directly observe the behaviors of crystal defects with real-time moving images in 1968. With development of the crystal lattice defect direct viewing instrument, it became possible to directly observe defects in crystals and the growth of crystals with motion pictures, thereby, revealing the effects of dynamic behavior at the crystal-growth point of silicones. This dynamic observation method developed into the globally attention-getting crystal observation technology. With introduction of this equipment, the relationship between the quality of crystals and the performance of devices was revealed in detail, consequently serving for the improvement of the production of semiconductors and processing and contributing to the later prosperity of semiconductor industries as well.

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Semiconductor Passivation Technology

Passivation of the surface of semiconductors to stabilize its properties has been an outstanding issue since the development of semiconductor devices and has been emphasized in terms of building high reliability. For semiconductor devices where silicon is used as a chief material, the planar method—SiO_2-film is used to mask the impurity diffusion and then left on the surface of the device—was widely employed. However, it had limitations in improving the quantity of properties controlled by surface properties, e.g., noise of transistors, amplification rate, and reverse high voltage. Masami Tomono, Takashi Tokuyama, Masayuki Yamamoto, et al. carried out basic research to conduct passivation at low temperature and developed the low temperature passivation (LTP) transistor having properties such as high-volume production, high reliability, low noise and resin molding, and in 1968, eventually succeeded in the large scale industrialization of said technologies. In the course of this process, they also developed the mass production of transistors with very low-noise low-frequency waves. The developed semiconductor devices were widely used. Among others, the low-noise transistor was highly appreciated; consequently, they are recognized as pioneers in the development of semiconductors in Japan.