Exploration of characteristics in the thin films of Zirconium oxide prepared by anodic oxidation met

蘇家慧、胡永枏、柯鴻禧

E-mail: 344743@mail.dyu.edu.tw

ABSTRACT

It has been years that in semiconductor integrated circuit manufacturing, people have successfully used SiO2 as gate dielectric material in MOSFET and other related device. Recently, due to the improvement of semiconductor technique, the size of device has been reducing in order to increase the density of integrated circuit device greatly. For example, one of the techniques is to do shrink by Moore ’ s Law. Nowadays, by applying metal-oxide-semiconductor, the device can be reduced to nanometer. However, because of the small size of device, the thickness of gate oxidation layer will be reduced which will cause tunneling effect. The leakage current will increase and the characteristic of device will be poorer. For solving the problem of small size of device and the leakage current, the research of high-k material has been updated. The surface morphology of zirconium oxide films was measured by atomic force microscope (AFM), the thickness of oxide film observed from the transmission electron microscopy (TEM), the grown oxide films of which thickness, stacked layers ’ structure, grain size and surface roughness (Ra) vary with oxidation time. Observing from the microscopic point of view, the nuclei of zirconium oxide started growing from the bottom (substrate surface) and gradually stacking up into a tetrahedral shape. The steep-grown tetrahedral are squeezed by 3D image processing. The resemble patterns show mainly square and rectangle shapes of which size are growing larger with increasing oxidation time. The crystal structure, showing tetrahedral according to the measurement, seems unrelated to the oxidation time, but the binding energy of Zr3d, measured on surface and depths of the oxidation films by X-Ray Photoemission spectra (XPS), increase with oxidation time. This study, therefore, focuses on the research of gate oxide layer producing technique.

Keywords : Zirconium, anodic oxidation, atomic force microscopy, tetrahedral

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