Oxygen pressure dependence and monopolar conductivity of Al$_2$O$_3$ thin films by pulsed laser deposition method

G. Z. Geng$^{1,2}$, F. K. Shan$^{1,2}$, Q. Zhang$^{1,2}$, G. X. Liu$^1$, B. C. Shin$^2$, W. J. Lee$^2$, I. S. Kim$^2$, C. R. Cho$^3$

$^1$College of Physics Science and Lab of New Fiber Materials and Modern Textile, Growing Base for State Key Laboratory, Qingdao University, Qingdao 266071, China
$^2$Electronic Ceramics Center, DongEui University, Busan 614-714, Korea
$^3$College of Nanoscience and Nanotechnology, Pusan National University, Busan 609-735, Korea

Submitting & presenting author: gengguangzhou@gmail.com
Corresponding author: fkshan@qdu.edu.cn
Also for correspondence: shinbc@deu.ac.kr

Al$_2$O$_3$ is considered as one of the potential materials for replacing SiO$_2$ in high k dielectric applications, and it has been prepared by many methods [1-4]. To further investigate the material, Al$_2$O$_3$ thin films were deposited at room temperature by pulsed laser deposition method at different oxygen pressures on p-type Si substrates. As confirmed by the x-ray diffraction results, the Al$_2$O$_3$ thin films were amorphous. The grain size, as well as the growth rate, increased obviously with the O$_2$ pressure. As a consequence, the surface roughness of the Al$_2$O$_3$ thin films also increased with increasing pressure. To study the electric and dielectric property of the films, Al-Al$_2$O$_3$-Si structures were fabricated. It was found that the capacitance of the Al$_2$O$_3$ thin film showed a strong relationship with O$_2$ pressure. Due to less oxygen vacancies and improved crystal quality at higher O$_2$ pressures, the leakage current decreased with the O$_2$ pressure. At a positive bias, the current in the dark was not large and rapidly saturated. However, under illumination the current became larger, which indicated a monopolar mechanism of Al$_2$O$_3$ conduction [5].