

Study of $\text{Hf}_x\text{Zr}_{1-x}\text{O}_2/\text{Si}$ interface potential by terahertz emission spectroscopy

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Hafnium zirconium oxide ($\text{Hf}_x\text{Zr}_{1-x}\text{O}_2$, HZO) is a key material in semiconductor technologies due to its ferroelectricity and high dielectric constant. However, the performance of HZO-based devices is strongly affected by the HZO/Si interface, where charge trapping and potential shifts occur. While bulk HZO properties are well-studied, interfacial dynamics remain unclear, posing challenges for device optimization. This study uses terahertz emission spectroscopy (TES), a non-contact characterization method, to examine the interface potential and charge dynamics of HZO/Si heterostructures. Figure 1(a) shows stronger conduction band bending and higher THz emission with increasing Zr content, attributed to interface states like vacancies. As gate voltage increases from -5V to 15V, THz amplitude decreases, indicating a reversal from accumulation to depletion/inversion, approximating the flat-band voltage, as shown in Figure 1(b). This work was supported by JST, CREST Grant Number JPMJCR22O2, Japan.

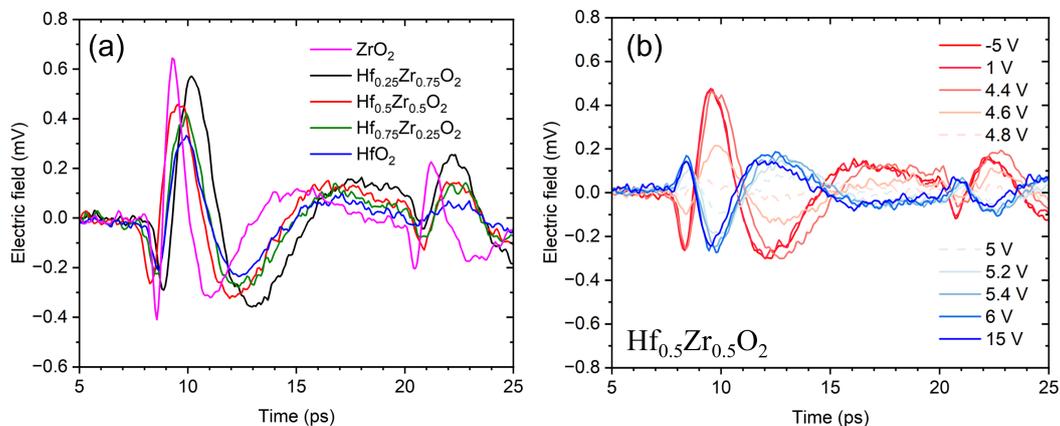


Figure 1. (a) THz waveforms emitted from HZO/*p*-Si samples with different Hf and Zr content; (b) THz waveforms emitted from $\text{Hf}_{0.5}\text{Zr}_{0.5}\text{O}_2/\text{p}$ -Si sample with different voltages

References:

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- [2] T. Mochizuki et al., Appl. Phys. Lett., 110, 163502 (2017).