氧化鑭，氧化鐠及氧化鉿高介電層特性之研究

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摘要

根據半導體的微縮定律，隨著元件持續的微小化，極薄的二氧化矽介電層將伴隨著極大的直接穿遂漏電流，而此直接穿遂漏電流將對元件的功率消耗有嚴重的影響。在閘極二氧化矽介電層薄至 1 奈米以下時，為解決此一嚴重的直接穿遂漏電流現象，勢必須利用高介電係數材料來替換傳統的二氧化矽。因為高介電係數材料在相同的等效二氧化矽厚度時，具有較大的實際物理厚度，故可降低直接穿遂漏電流。

近幾年，有很多研究在探討二氧化鉿介電層的特性。但最近稀土金屬氧化物如氧化鑭和氧化鐠也開始受到重視。由於目前相關文獻不多，故在論文中，我們試著用物理沈積的方法，去製作氧化鑭和氧化鐠介電層，並對其做一些基本電性的研究。

相較於前二者，二氧化鉿介電層已被研究很久。因此在論文中，

我們對二氧化鉿介電層施以低溫氨氣的氮化處理(~400 ^{o}C)，來提昇其電特性。並對有低溫氨氣處理的試片做一些電性分析，如漏電流、崩潰電場和電性逼迫處造成之漏電流等等。最後從我們的實驗結果顯示，低溫氨氣處理在提昇二氧化鉿的特性上確是一個可行的方法。

The study of Electrical Properties on La_2O_3, Pr_2O_3 and HfO_2 Gate Dielectrics

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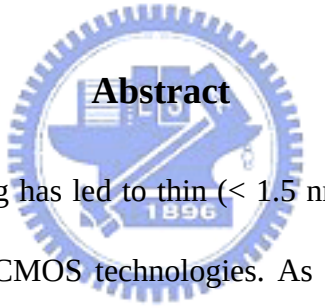

Abstract

Aggressive device scaling has led to thin (< 1.5 nm) silicon dioxide (SiO_2) gate dielectrics in state-of-the-art CMOS technologies. As a result, static leakage power due to direct tunneling through the gate oxide has been increasing at an exponential rate. As technology roadmaps call for sub-15Å gate oxides within the next five years, a variety of alternative high-*k* materials are being investigated as possible replacements for SiO_2. The higher dielectric constant in these materials allows the use of physically thicker films, thus potentially reducing the tunneling current while maintaining the gate capacitance needed for scaled device operation.

In the last few years, much work has been done to understand the properties of HfO_2 gate dielectrics. More recently, rare earth metal oxides such as amorphous La_2O_3 and epitaxial Pr_2O_3 films deposited on Si substrates have received much attention. In

this thesis, we used physical vapor deposition (PVD) method to deposit La_2O_3 and Pr_2O_3 gate dielectrics and studied the electrical characteristics of these gate dielectrics.

HfO_2 films as potential gate dielectric have been studied for a long time. In this thesis, low temperature (~ 400℃) NH_3 treatment on HfO_2 gate dielectrics was used to improve the electrical properties. Electrical characteristics of HfO_2 gate dielectrics including leakage current, breakdown field, and stress induced leakage current (SILC) were measured on samples with low temperature nitridation. Our results show that the low temperature treatment appears to be an effective method to improve the HfO_2 gate dielectrics.

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