基于 ALD Al_2O_3 新型反熔丝器件的可靠性研究

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摘 要：金属-绝缘体-金属(Metal-Insulator-Metal, MIM)反熔丝器件常被用于现场可编程逻辑阵列(Field Programmable Gate Array,FPGA)的互联结构单元.本文使用高介电常数材料 Al_2O_3 作为介质层，使用原子层沉积(Atomic Layer Deposition, ALD)技术,制备了高可靠性，高性能的 MIM 反熔丝单元.该反熔丝单元关态电阻超过 1TΩ，同时开态电阻非常低，满足正态分布，集中在 22 Ω左右，波动幅度很小，标准差仅为 3.7 Ω，因此 Al_2O_3 反熔丝器件具有很高的开关比.本文研究了该器件编程前后两种状态的特性及时变击穿特性(Time Dependent Dielectric Breakdown, TDDB).研究结果表明，在 2 V 工作电压下，未编程的反熔丝单元的预测寿命为 1591 年，同时，当读电流在 0~20 mA 时，编程后的反熔丝保持稳定.这说明该反熔丝单元在低阻态和高阻态都具有非常高的可靠性.

关键词：金属-绝缘体-金属反熔丝；原子层沉积；开关比；时变击穿特性

Study on Reliability of A New Anti-fuse Device Based on ALD Al_2O_3

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Abstract：Metal-Insulator-Metal (MIM) antifuse has always been used in Field Programmable Gate Array (FPGA) interconnection structure unit. A High-performance and High-reliability Metal-Insulator-Metal antifuse was fabricated with high SymbolkA@Al_2O_3 deposited by Atomic Layer Deposition (ALD) as the dielectric. The anti-fuse unit's off-state resistance exceeds 1TΩ, and the on-state resistance is very low, which satisfies the normal distribution, the on-resistance value is concentrated around 22Ω, and the standard deviation is only 3.7Ω, so it has high on/off ratio. In this paper, the Time Dependent DielectricBreakdown (TDDB) of the structure is studied. The results show that the predicted lifetime of the unprogrammed anti-fuse cell is 1591 years at 2V operating voltage. At the same time, when the read current is 0~20mA, the programmed anti-fuse remains stable. This shows that the antifuse has a very high reliability in both low-impedance and high-impedance states.

Key words：metal-insulator-metalanti-fuse; atomic layer deposition; on/off ratio;time dependent dielectric breakdown

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