Resumen de Tesis Doctoral

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Título de la tesis	4H-SiC Integrated Circuits for High Temperature and Harsh Environment Applications
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(Mínimo 1 y màximo 4, podéis verlos en http://doctorat.upc.edu/gestion-academica/carpeta-impresos/tesis-matricula-y-deposito/codigos-unesco)

Resumen de la tesis de 4000 caracteres máximo (si se superan los 4000 se cortará automáticamente)

Silicon Carbide (SiC) has received a special attention in the last decades thanks to its superior electrical, mechanical and chemical proprieties. SiC is mostly used for applications where Silicon is limited, becoming a proper material for both unipolar and bipolar power device able to work under high power, high frequency and high temperature conditions.
Aside from the outstanding theoretical and practical advantages still to be proved in SiC devices, the need for more accurate models for the design and optimization of these devices, along with the development of integrated circuits (ICs) on SiC is indispensable for the further success of modern power electronics.
The design and development of SiC ICs has become a necessity since the high temperature operation of ICs is expected to enable important improvements in aerospace, automotive, energy production and other industrial systems. Due to the last impressive progresses in the manufacturing of high quality SiC substrates, the possibility of developing ICs applications is now feasible. SiC unipolar transistors, such as JFETs and MESFETs show a promising potential for digital ICs operating at high temperature and in harsh environments.
The reported ICs on SiC have been realized so far with either a small number of elements, or with a low integration density. Therefore, this work demonstrates that by means of our SiC MESFET technology, multi-stage digital ICs fabrication containing a large number of 4H-SiC devices is feasible, accomplishing some of the most important ICs requirements. The ultimate objective is the development of SiC digital building blocks by transferring the Si CMOS topologies, hence demonstrating that the ICs SiC technology can be an important competitor of the Si ICs technology especially in application fields in which high temperature, high switching speed and harsh environment operations are required.
The study starts with the current normally-on SiC MESFET CNM complete analysis of an already fabricated MESFET. It continues with the modeling and fabrication of a new planar-MESFET structure together with new epitaxial resistors specially suited for high temperature and high integration density. A novel device isolation technique never used on SiC before is approached. A fabrication process flow with three metal levels fully compatible with the CMOS technology is defined. An exhaustive experimental characterization at room and high temperature (300ºC) and Spice parameter extractions for both structures are performed.
In order to design digital ICs on SiC with the previously developed devices, the current available topologies for normally-on transistors are discussed. The circuits design using Spice modeling, the process technology, the fabrication and the testing of the 4H-SiC MESFET elementary logic gates library at high temperature and high frequencies are performed. The MESFET logic basic behavior up to 300ºC is analyzed. Finally, this library has allowed us implementing complex multi-stage logic circuits with three metal levels and a process flow fully compatible with a CMOS technology.
This study demonstrates that the development of important SiC digital blocks by transferring CMOS topologies (such as Master Slave Data Flip-Flop and Data-Reset Flip-Flop) is successfully achieved. Hence, demonstrating that our 4H-SiC MESFET technology enables the fabrication of mixed signal ICs capable to operate at high temperature (300ºC) and high frequencies (300kHz). We consider this study an important step ahead regarding the future ICs developments on SiC.
Finally, experimental irradiations were performed on W-Schotthy diodes and mesa-MESFET devices (with the same Schottky gate than the planar SiC MESFET) in order to study their radiation hardness stability. The good radiation endurance of SiC Schottky-gate devices is proven. It is expected that the new developed devices with the same W-Schottky gate, to have a similar behavior in radiation rich environments.

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