Preface

In electronic warfare (EW), military forces rely on focused electromagnetic energy such as radio waves, infrared radiation, radar and high-powered laser light to intercept, manipulate or disable an adversary's electronic equipment. Successful EW techniques require mature, efficient, high-powered, high-frequency and reliable electronic devices where the choice of enabling technology is application dependent. Soldiers rely on equipment to operate faultlessly in various and often harsh environmental conditions. It is not uncommon for defective equipment to have fatal consequences in certain circumstances. Furthermore, military activity is increasingly becoming more reliant on technology for surveillance, reconnaissance and gathering intelligence. Advances in technology miniaturization and efficiency are ensuring rapid progress in electronic attack (EA), electronic protection (EP) and electronic support (ES), the three major areas of EW. Information warfare is also reliant on electronic equipment to process, store and display large amounts of data instantly, using high-frequency and dependable technologies. High-powered equipment can be used as weapons to destroy electronic equipment and even physically damage vehicles or buildings, or cause harm to humans. The mobility of these weapons is typically problematic, since the electronic subsystems are large and bulky, which is another motivation to miniaturize the electronic supporting circuitry to improve mobility.

Semiconductor processing has also evolved to facilitate complex processing and storage circuits occupying only a few millimetres of area. Integrated circuits (ICs) are the heart of most electronic devices capable of gathering, interpreting and storing digital information or generating, distributing and receiving analog signals. Semiconductor process technologies vary with respect to the application requirement. Inherent trade-offs between process technologies require thorough understanding and research of the requirements, limitations and advantages. Process technologies, such as silicon (Si) variants, which include complementary metal–oxide–semiconductors (CMOS) and Si-germanium (SiGe), indium phosphide (InP) variants, gallium arsenide (GaAs) variants and gallium nitride (GaN), can be used to realize complex, high-frequency and/or high-power ICs. In EW and in space-based applications, reliability in harsh conditions and physical size limitations are frequently required for electronic subsystems. A difficulty that restricts researchers from experimenting and iterating through new ideas and hypotheses regarding the advancement and improvement of EW subsystems is the cost of prototyping and testing submicron electronic circuits. Advantages of Si are a relatively low price to manufacture, high yields and global availability; its caveat, however, is the limitations of its performance. Materials with superior performance in terms of noise, operating speed or output power exist and are available for prototyping, but the higher costs or complex modelling repeatedly deters researchers (and experts) from implementing these technologies.

This book, *SiGe-based Re-engineering of Electronic Warfare Subsystems*, provides a comprehensive and relevant arrangement on the applicability of new generation SiGe electronic subsystems in EW equipment. The definition of EW is expanding, with new innovations and replacement technologies becoming more feasible. Although considered somewhat futuristic, charged particle beam acceleration and laser weapons are becoming increasingly more conceivable, using modern high-powered electronic devices accompanied by rapidly switching supporting circuitry. The basis of these technologies is not new, but their application as offensive or defensive weapons is still at the experimental stage. The fundamental principles of charged particle beam acceleration and lasers are reviewed and presented in this book, highlighting the roles that microelectronic components play in facilitating these weapons and applications, such as laser rangefinders. The generation of laser light also allows optoelectronic communication and microwave photonics, transmitting data by using light as the modulating medium. Optoelectronic communication presents superior performance in bandwidth and low-noise operation, compared to traditional copper and microwave transmissions. High-speed signal processing and complex ICs are requirements of the supporting circuitry to enable optoelectronic communication to operate at its potential maximum bandwidth, ideally using low-cost and mature technology. In addition, the possibility of realizing optic and electronic circuitry on a single die makes SiGe (in view of its Si substrate) a dominant contender in this research discipline. The characteristics of SiGe permit its use in EW, and this book exploits its advantages and provides an in-depth review of the subsystems where SiGe presents the ideal replacement technology for previous and current generation systems.

SiGe offers additional advantageous characteristics compared to traditional CMOS technologies for high-radiation environments, such as in low-earth orbit where space EW offers tactical advantages in EA, EP and ES. An in-depth review of the semiconductor component construction in SiGe is presented in this book to provide better understanding of the inherent radiation-hardened characteristics of SiGe, accompanied by a review of the mechanisms that lead to single event upsets or permanent material damage due to radiation.

SiGe-based Re-engineering of Electronic Warfare Subsystems concludes in the final two chapters by reviewing the potential future of EW and the potential contributions that SiGe can offer. Numerous technologies such as traditional Si, wide bandgap materials such as GaN and silicon carbide and high-speed technologies such as InP and GaAs exist and are being used for various applications in the military, space and commercial sectors. The authors have taken it upon themselves to write this book specifically to address these research topics and empower the scholarly community through this research—integrating EW.

Johannesburg, South Africa Wynand Lambrechts
Saurabh Sinha

Springer

http://www.springer.com/978-3-319-47402-1

SiGe-based Re-engineering of Electronic Warfare Subsystems
Lambrechts, W.; Sinha, S.
2017, XX, 329 p. 118 illus., Hardcover
ISBN: 978-3-319-47402-1