Preface

Over the last few years, new technologies have dramatically taken hold of the non-volatile memories industry, which had been dominated for a long time by Flash technology.

The reason can be found partly in the fact that it has become increasingly difficult to overcome Flash's technological and physical limits in order to continue following the path of dimensional reduction.

Even if we know from experience that those limits are, in fact, partial and that they keep moving yet forward as technology progresses, it is evident that more and more financial resources and efforts are needed to finally overcome them. However, an incentive for change also comes from new application requirements that demand real-time elaboration and permanent memorization of a large amount of data.

The current memory system, based on fast and temporary memory (DRAM) and permanent memory (NAND), seems to be insufficient to meet the new demands. In addition, the development of DRAM technology is facing difficulties that are similar to those found with NAND.

For all these reasons, many expectations have been put on new technologies in the hope of finding one of them to be the ideal memory.

Since there are various new proposals based on very different physical principles, it is not always easy to clearly identify the pros and cons of each approach and to recognize analogies and differences. The idea behind this book is to provide a little help in this direction.

We start with a brief description of mainstream Flash technology, the main problems that make it difficult to proceed further with it, and the solutions that have been adopted to assure its survival. Then, we turn to breakthrough approaches, trying to compare some proven emerging technologies while analyzing their operating principles and the essential building blocks of related device architecture.

We believe that a fundamental theme is programming algorithms, and we pay careful attention to them. They are very important in the current NAND technology. Despite the initial hopes to do without them, they are still crucial for some new emerging technologies. The same applies to on-board systems for error correction,

which are now becoming an integral part of the new architecture for high-density memories.

Lastly, we briefly touch upon the theme of device sensitivity to high-energy radiation. Usually, it is an area of expertise for specialists and may seem an odd topic, considering the main theme of this book.

However, we wanted to add this part because the technology of the new memories has been considered very interesting also in this respect, raising the hope of decisive performance improvement for devices operating in a high-energy radiation environment.

Certainly, we do not expect this book to be exhaustive: such a dynamic field as non-volatile memories has generated and still generates many innovative ideas, some of them introducing new concepts, and others recalling already-known notions.

We decided to examine only those technologies that have developed to a certain level of maturity. Other technologies are still in an early stage of research, and we decided not to talk about them in this book, but this choice, however, should not be seen as a negative opinion about the possibility that some of them will be successful in the future.

This book could never have been written without the help and support of the many people who collaborated for its realization with enthusiasm and knowledge. Therefore, we would like to thank:

Roberto Bez, who wrote the introduction and with whom we shared many years of work in the central R&D group of STMicroelectronics in Agrate;

Agostino Pirovano, curator of the chapter dedicated to emerging memories' technological aspects;

Guido Torelli and Alessandro Cabrini for their valuable expertise in defining programming algorithms for PCM memories;

Andrea Fantini, who worked on programming ReRAM memories;

Paolo Amato and Marco Sforzin, who dedicated themselves to the error-correction system, a crucial aspect of new technologies;

Carmen Wolf and Christoph Baumann from the Springer publishing house, who helped us with competence in every step of the realization of this book and Ken Quinn for the meticulous linguistic revision process.

We would like to offer special thanks to our families who willingly accepted for fitting part of the time that otherwise would have been dedicated to them so that we could complete this project.

Our sincere hope is that this simple work can guide those who are interested in the world of emerging non-volatile memories, mainly from a designer prospective, but also from the user's point of view, and help those who wish to keep up with the new developments in memories that are achieving an increasingly crucial role in data processing systems of the present and very likely in the future.

A teacher once asked his four students to define what memory is.

After a few days, he met them again and asked if they had come up with the definition.

The first student said: "memory is the ability to keep and reproduce previous thoughts without the reasoning that gave rise to them being present, in the same way as reminiscence is the ability to recollect in our mind things we have learned." You are really good, the teacher said. You will go a long way with your philosophical skills.

The second student said: "memory is the ability to store information, from the simple details of everyday life to complex concepts such as knowledge of abstract geography or algebra. Surely it is one of the most extraordinary aspects of human behavior." Good, the teacher said. You will definitely become a great medical researcher.

The third student answered: "memory is part of a system that registers and stores data and instructions for further elaboration." I see you are analyzing technical aspects of memory, the teacher said. You will be a great technician.

The fourth student said: "memory enables us to preserve experiences, therefore to recollect anything in our heart that might invoke mercy, so that our heart can be touched by other People's. "The teacher after hearing this said: "I am your student."

Milan, Italy
September 2016

Roberto Gastaldi
Giovanni Campardo

http://www.springer.com/978-3-319-47722-0

In Search of the Next Memory
Inside the Circuitry from the Oldest to the Emerging Non-Volatile Memories
Gastaldi, R.; Campardo, G. (Eds.)
2017, XVIII, 247 p. 185 illus., Hardcover
ISBN: 978-3-319-47722-0