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M. Alexe U. Gösele (Eds.)

Wafer Bonding

Applications and Technology

With 372 Figures and 25 Tables

Springer

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Preface

Wafer bonding, also known as direct wafer bonding or wafer fusion, has developed from an almost obscure niche technology in the 1980s to a versatile base technology which is more and more applied in actual high-tech products. The present book will not concentrate so much on the basics and the science of wafer bonding which have been described in many hundreds of original publications, conference proceedings, numerous review articles and books, but rather on more applied and technological aspects of wafer bonding. Consequently, we have asked many authors from companies and sometimes also from competing companies to give their point of view, including perspectives on actual production and economic issues. Fortunately only in a few cases were we turned down by companies which were not willing to describe their substantial activities in the general area of wafer bonding. If the reader misses some of the obvious players in the field then this absence is certainly not due to the lack of trying on the part of the editors.

Purposely the book starts with a wide-ranging chapter on the history of patents in wafer bonding which gives a very general overview on the development of wafer bonding from the medieval ages over the time in which first developments could actually be patented to the more recent patent history.

The main commercial application of wafer bonding is in the area of silicon-on-insulator (SOI) technology. The basics of SOI technology therefore is described in a special chapter by one of the pioneers in the field of SOI devices. Two of the main technologies to fabricate thin film SOI wafers by wafer bonding (UNIBOND and ELTRAN) are described by representatives of the respective companies, SOITEC and Canon. The use of wafer bonding for future advanced digital electronic nano-devices is described by an author from IBM's Watson Research Labs in a chapter also touching on strained silicon devices and SiGe technology. A subsequent chapter is devoted to the very different fabrication of much thicker SOI layers in the range of many microns and their applications in numerous power and high voltage and analog devices presented in a contribution from Analog Devices.

Most of the subsequent chapters written by authors from public research organisations and universities deal with processes and devices which are not yet in production but clearly have the potential to get there. We have asked the authors to mention also technologies which could be considered as competing with wafer bonding and many authors followed our suggestion which allows the reader to get some information also on competing technologies. There are special chapters which deal mainly with partly competing and partly complementary technologies such as laser lift-off and crystal-ion slicing. The hybrid integration of optoelec-

tronics and microelectronics as well as the integration of ferroelectric layers and silicon by wafer bonding are described in two chapters. The use of wafer bonding for the fabrication of three-dimensional photonic crystals, described in the chapter from Kyoto University, is surprising and technologically elegant. One chapter coming from a Fraunhofer Institute is devoted to the question of how bonded wafers can be most efficiently debonded again, as this is of major interest for many practical applications. The final two chapters deal with wafer bonding approaches in optoelectronics, partly already in production, and with the development of new alternative substrates with single crystalline SiC layers, which will become important as much less expensive substitutes for bulk SiC wafers.

Let us finally mention that we are convinced that the enhanced design freedom in materials integration which is enabled by wafer bonding approaches will lead to many more unexpected technological solutions in the future. It appears to us that in the area of materials integration and the resulting devices, in many cases we are now more restricted by our limited imagination than by limitations in technology.

Halle, February 2004

Marin Alexe
Ulrich M. Gösele

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