PREFACE

Laser Cleaning II is the second book to update research on the use of lasers to remove contamination from surfaces, with a primary, but non-exclusive, focus on contaminant particle removal. It is sub-micron and nano-scale sized particles, in particular, that can adhere very strongly to surfaces and present a key cleaning challenge, in the broad context of cleaning science and technology. Some of these challenges, relevant to the semiconductor fabrication industry, are documented in the International Technology Roadmap for Semiconductors*. Other significant application areas are optics and photonics, biotechnology, nuclear decontamination and the automotive industry. Discoveries related to the near-field focussing of the laser beam by sub-micron and nano-scale particles on surfaces have led to a new branch of investigation using this as a method of nano-patterning and nano-structuring surfaces described in this book. Laser cleaning for Art and Cultural Heritage Conservation is a related, mature field of research and there are also chapters here-in that are cross-linked to this research area. The first book *Laser Cleaning*, edited by Boris Luk'yanchuk, was published in 2002. This second book is dedicated to him as an appropriate way to mark the occasion of his 60th birthday. It includes chapters that are original, peer reviewed, research papers, presented at the 4th International Workshop on Laser Cleaning/ New Trends in Laser Cleaning III, (IWLC4/NeToLAC III) held in Sydney in December 2004, and research review chapters.

As the knowledge and understanding of laser cleaning science and processes increases, some key insights into the interplay of ideal theory and physical reality are emerging. If nano-scale particles are adhered to a surface by van der Waals-force-adhesion, then dry laser cleaning of these particles from the surface will not be achieved without laser-induced damage to the underlying surface. However, it emerges that in many "real" physical cases, the particles, either introduced "dry" or from a suspension, do not approach the surface closely enough (due to electrostatic, capillary and/or moisture film effects) and so can have an adhesion to the surface orders of magnitude smaller than the

*International Technology Roadmap for Semiconductors 2003 Edition, 2004 tables Updates, http://public.itrs.net/, accessed 14/2/05, in particular "Front End Processes" section.

idealised "0.4 nm spaced" van der Waals force. Thus, the theoretical predictions of laser pulse energy required for laser cleaning, based on van der Waals adhesion, are a "worst case" scenario. The adhesion in real cleaning applications can be significantly less and therefore successful dry laser cleaning can be achieved in many cases. If the adhesion is consistent with van der Waal's; which will be the case in ultraclean, dry, electrically-neutral environments; then steam laser cleaning and hybrid laser cleaning (that combine laser cleaning with other cleaning methods such as ultrasonic/megasonic cleaning, dry CO_2 (snow) cleaning, shockwave cleaning, brushing etc.) may be preferred. Such techniques may be preferred for process/manufacturing-related reasons in any case. Progress in laser cleaning research, as described in Laser Cleaning and Laser Cleaning II (this book), has been facilitated by the strong interaction between top theoretical physicists and experimentalists in the field. In my opinion, the "story" of laser cleaning is of interest to a broader readership than those in the field for this reason. A significant part of this story is the work of Professor Boris Luk'yanchuk and it is a pleasure to celebrate his career — a lifetime of dedication to high-level theoretical physics — and to mark the occasion of his 60th birthday by dedicating this book to him.

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