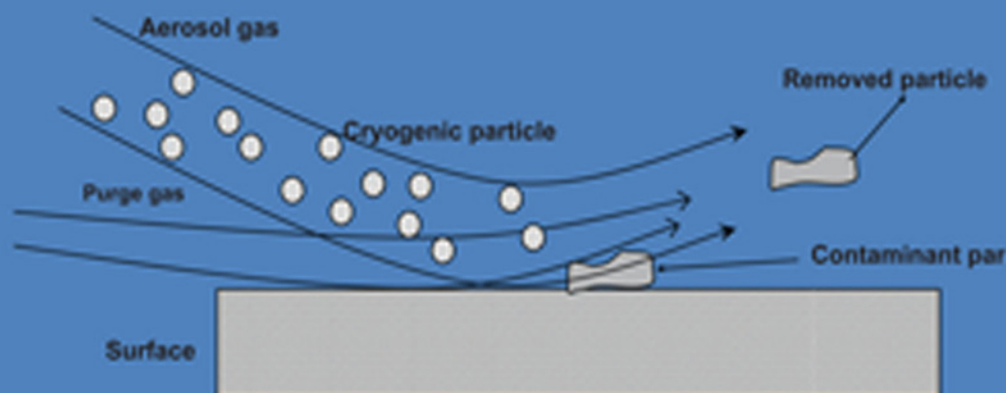


PARTICLE ADHESION AND REMOVAL



Edited by K.L. Mittal and Ravi Jaiswal

Particle Adhesion and Removal

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Adhesion and Adhesives: Fundamental and Applied Aspects

The topics to be covered include, but not limited to, basic and theoretical aspects of adhesion; modeling of adhesion phenomena; mechanisms of adhesion; surface and interfacial analysis and characterization; unraveling of events at interfaces; characterization of interphases; adhesion of thin films and coatings; adhesion aspects in reinforced composites; formation, characterization and durability of adhesive joints; surface preparation methods; polymer surface modification; biological adhesion; particle adhesion; adhesion of metallized plastics; adhesion of diamond-like films; adhesion promoters; contact angle, wettability and adhesion; superhydrophobicity and superhydrophilicity. With regards to adhesives, the Series will include, but not limited to, green adhesives; novel and high-performance adhesives; and medical adhesive applications.

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Preface

The importance of particle adhesion and removal is quite manifest in many areas of human endeavor (ranging from microelectronics to optics, and space to biomedical). A complete catalog of modern precision and sophisticated technologies where removal of particles from surfaces is of cardinal importance will be prohibitively long, but the following eclectic examples should suffice to underscore the concern about particles on a variety of surfaces where particulate contamination is a *bête noire*. In the semiconductor world of ever-shrinking dimensions, particles which, just a few years ago, were cosmetically undesirable but functionally innocuous, are now “killer” defects. As device sizes get smaller, there will be more and more concern about smaller and smaller particles. In the information storage technology, the gap between the head and the disk is very narrow, and if a particle is trapped in the gap this can have very grave consequences. The implications of particulate contamination on sensitive optical surfaces are all too manifest. So the particulate contamination on surfaces is an anathema from functional, yield, and reliability points of view. With the burgeoning interest in nanotechnologies, the need to remove nano and sub-nano particles will be more and more intense. Apropos, it should be mentioned that in some situations, particle adhesion is a desideratum. For example, in photocopying the toner particles must adhere well to obtain photocopies, but these should not adhere to wrong places otherwise the result will be a dirty photocopy. Here also one can see the importance of particle removal.

One of us (KLM) has edited a series of books called “Particles on Surfaces: Detection, Adhesion and Removal” but the last volume (Volume 9) was published in 2006. Since 2006 there has been an enormous level of research activity, particularly in removing nanosize particles, and thus it was obvious that recent developments needed consolidation and this provided the vindication for the present book. This book was conceived with the core purpose of providing a comprehensive and easily accessible

reference source covering important aspects/ramifications of particle adhesion and removal, with emphasis on recent developments in understanding nanoparticle adhesion mechanism(s) and their removal. All signals indicate that R&D activity in the arena of removal of nanometer size particles will continue unabated.

Now coming to this book (containing 14 chapters), it is divided into two parts: Part 1: Particle Adhesion: Fundamentals, and Part 2: Particle Removal Techniques. The topics covered include: Fundamental forces in particle adhesion; mechanics of particle adhesion and removal; microscopic particle adhesion models and surface modified particles; characterization of single particle adhesion; high intensity ultrasonic removal of particles; megasonic cleaning for particle removal; high speed air jet removal of particles; droplet spray technique for particle removal; laser-induced high-pressure micro-spray technique for particle removal; wiper-based cleaning of particles; application of strippable coatings for removal of particulate contaminants; cryogenic cleaning of particles; supercritical carbon dioxide cleaning; relevance to particle removal; and use of surfactants to enhance particle removal.

This book represents the cumulative contribution of many internationally renowned subject matter experts in the domain of particle adhesion and removal. The book reflects the state-of-the-art with special attention to recent and novel developments.

The book containing bountiful information on the fundamental and applied aspects of particle adhesion and removal provides a unified and comprehensive source. It should serve as a portal for the neophyte and a commentary on the recent developments for the veteran. The book should be of interest to researchers in academia and R&D, manufacturing, and quality control personnel in microelectronics, aerospace, automotive, optics, solar panels, pharmaceutical, biomedical, equipment cleaning and wafer reclaiming industries. Essentially, anyone involved in or concerned with removal of particles should find this book of immense value. Also, we hope that this book will serve as a fountainhead for new ideas pertaining to particle removal.

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