Preface

Adhesion between similar or dissimilar materials is of vital importance to IBM in the manufacture of products such as multilayer electronic devices and integrated circuits, printed circuit boards, and magnetic head and disk assemblies. For products to function reliably and reproducibly, ways must be devised to understand and tailor the requisite adhesion strengths between materials.

Strictly speaking, adhesion is an interfacial phenomenon, but the overall adhesion strength, commonly referred to as practical adhesion, is generally determined by the properties of an interfacial region or "interphase" between the two materials, which differ from those of the two contiguous bulk phases. An interphase might be present naturally or be created by interactions, such as diffusion, between the adhering phases. Desirable interphases are obtained by introducing coupling agents or adhesion promoters, by enhancing interdiffusion, by application of a surface modification technique, or by eliminating unwanted surfaces.

The ability to accurately measure the properties of relevant surfaces and interphases and correlate them with adhesion strength enhances our understanding of the factors that affect adhesion. The increased availability of modern analytical techniques and experimental tools, as well as novel theoretical approaches, has opened new vistas to achieving this understanding.

The eight papers in this special issue of the *IBM Journal of Research and Development* highlight developments in adhesion science and technology that are currently of interest within IBM. The first three papers focus on the fundamental aspects of adhesion. In the first paper, Dürig analyzes the metal tip–sample interactions which occur in a scanning tunneling microscope during vacuum tunneling at distances where electron wave functions overlap appreciably. These interactions are associated with adhesion at an atomic level. The next paper, by Thouless, examines aspects of the fracture mechanics of thin-film adhesion. The author reviews the essential elements of the mechanics of delamination and discusses their implications for flaw-tolerant design of structures involving thin films. In the third paper, Brown reviews recent work that relates to adhesion between noninteracting polymers. Advances in the understanding of adhesion failure between polymers and the interpretation of adhesion tests are discussed. The use of copolymers as coupling agents to improve adhesion between immiscible polymers is also described.

The fourth paper, by Spool, reviews the application of static and dynamic secondary ion mass spectroscopy (SIMS) as analytical tools for identifying factors that affect adhesion. The high mass resolution of SIMS makes it particularly useful in identifying trace impurities at surfaces and diffusion of species near the interfacial region. Spool cites examples of the utility of static SIMS in gaining an understanding of the nature of failed surfaces, of pre-bonding treatments, of adhesion-weakening contaminants, and of adhesion promoters.

The next four papers are primarily concerned with ways to improve adhesion. The review paper by Baglin focuses on ion beam techniques to improve adhesion of thin films to a variety of substrates. The techniques discussed are reactive and nonreactive ion beam sputtering, ion-beam-assisted deposition, ion beam stitching, and ion implantation. Eclectic examples are cited to show enhancements in adhesion strengths that are a result of ion beam treatments. The paper by Egitto and Matienzo reviews plasma technology and its ability to modify polymer surfaces to improve adhesion characteristics without affecting the bulk properties of the polymer. Plasmas enhance adhesion by removing contaminants, roughening surfaces, and introducing reactive chemical groups. In the next paper, Saraf et al. demonstrate that adhesion to a flexible polyimide surface can be enhanced after replacing a single polyimide precursor with a blend of two precursors. An improvement in adhesion to such a polyimide surface is attributed to increased surface roughening, a more isotropic polymer chain ordering within the film, and a modified near-surface morphology. The last paper, by Lee and Viehbeck, is an overview of recent work on wet-process surface modifications of polymers. Wet processing is simple, low-cost processing that improves adhesion to the polymers by introducing reactive functional groups at the surface and by enhancing interdiffusion between polymers.

I wish to thank the authors of the submitted papers and the referees and express my hope that readers of this issue of the *IBM Journal of Research and Development* will find the papers both interesting and informative.

Dr. K. L. Mittal, *Guest Editor*
92 Saddle Ridge Drive
Hopewell Junction, NY 12533

Previous affiliation:
Skill Dynamics
An IBM Company