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Historical Evolution Toward Achieving Ultrahigh Vacuum in JEOL Electron Microscopes

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Preface

This book describes the history of how ultrahigh-vacuum (UHV) JEOL electron microscopes (JEM series) were brought into existence, from their conception to the birth of the electron microscope.

My co-workers and I engaged in developing vacuum technology for electron microscopes at JEOL (Japan Electron Optics Laboratory Co. Ltd.) for many years. This book now presents the UHV technology of JEMs.

The column of the electron microscope (EM), including the camera chamber, is very complex in construction and is composed of many units and parts.

A high-tension (HT) electron gun is installed on the top of the column for illuminating the specimen with a fine electron probe. A very clean vacuum is required for preventing contamination build-up on the specimen surface. When a microdischarge occurs on the HT electron gun, noiseless EM-image observation becomes impossible.

A very clean UHV around the specimen is essential. However, some types of UHV pumps, such as the turbo-molecular pump (TMP) and the cryopump (CP), cause vibration, making noiseless EM-image observation impossible.

We had to develop two types of sputter ion pumps (SIPs) for creating UHV-EMs, one having high pumping speeds in the UHV region, and the other having stable pumping performance for inert gases such as argon for thinning specimens, in addition to their demonstrating high performance in the UHV region. JEOL SIPs for our electron microscopes are described in detail in this book.

The users of EMs are high-level researchers, working at the frontiers of new materials or new biological specimens. They often use the EM under extreme conditions, with problems sometimes occurring in the vacuum system of the users' EMs. We must resolve such problems as quickly as possible and improve the vacuum system in order to prevent the recurrence of such problems. Typical examples of users' claims are presented in this book, such as microdischarge occurring on an electron gun and backstreaming of diffusion pump (DP) oil vapor. Accidents occurring in users' EMs showed us how to improve the vacuum systems of JEMs.

We sincerely hope that this short book will be read by many engineers and researchers using analytical instruments that employ a fine electron probe, such as the EM, the X-ray microanalyzer (XMA), and the Auger electron spectrometer (AES).

Tokyo, Japan Nagamitsu Yoshimura

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In addition, I am grateful to JEOL for permission to present its expert technologies based on our experiments.

Due thanks are given to colleagues at JEOL Ltd., especially to Mr. H. Hirano. Knowing that we all did our best in working on the vacuum technology for electron microscopes is indeed a nice memory.

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