History and Development of the Helium Ion Microscope

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The helium ion microscope has recently emerged as a commercially available instrument. However, its roots go back more than 60 years to the development of the field ion microscope in Berlin, first reported by Müller [(1)] in 1951. Over the intervening years, numerous researchers have pursued the development of a gas field ionization source (GFIS) with the goal of producing a suitable source for an ion microscope. Notable efforts during this extended period were undertaken at the University of Chicago[(2)], the Oregon Graduate Center[(3)], Cornell University[(4)] and the Max Planck Institute in Heidelberg[(5)], among others.

Progress on the GFIS has been characterized by slow advancement for long periods of time punctuated with periods of more rapid development. The fluctuating rates of progress were sometimes the consequence of technical hurdles that could not be overcome at a given point in time, but were surmounted when some other supporting technology matured and was brought into play. Market forces also affected the rate of development. As competing technologies progressed, they inevitably attracted resources away from work on the GFIS. The development of the liquid metal ion source (LMIS), which became viable in the 1980s, has been an area of intense activity and, during the period immediately following its invention, effectively halted any significant work on the GFIS for many years. In addition, advances and perceived limitations in electron microscope technology served to both drive and inhibit the search for a GFIS based instrument. Only when there emerged clear limitations to other technologies was GFIS work pursued again in earnest, starting in the early 1990s. The final successful push toward a practical GFIS began in 2002, leading to the formation of ALIS Corporation in 2005, the acquisition of ALIS by Carl Zeiss in 2006, and culminating in a commercial instrument in 2007.

In the past 60 years, many individuals and many technical advances have come together to make this new class of microscope. The long history of this quest will be reviewed along with the recent advances that led to the achievement of this milestone. A brief summary of the current status of the technology and its applications will be given.

[1] E. W. Müller, Zeitschrift für Physik **131**, 136 (1951).
[2] W. H. Escovitz, R. Fox, R. Levi-Setti, Proceedings of the National Academy of Science, **72**(5), 1826 (1975).
[3] J. H. Orloff, L. W. Swanson, Journal of Vacuum Science and Technology, **12**(6), 1209 (1975).
[4] G. R. Hanson, B. M. Siegel, Journal of Vacuum Science and Technology, **16**(6), 1875 (1979).
[5] C. Wilbertz, T. Maisch, K. Huttner, K. Bohringer, K. Jousten, S. Kalbitzer, Nuclear Instruments and Methods in Physics Research, **B63**(10), 1477 (1992).