SUMMARY

The work described in this thesis deals firstly with the theoretical and experimental discovery of the possibility to analyse atomic surface structures with multiple ion reflection (chapters II, III).

Secondly, the results are presented of the application of this multiple ion reflection technique to the study of nucleation and growth of evaporated films (chapter IV).

Finally a description is given of a one-apparatus noble gas ion probe technique, that gives information about the structure and composition (elements and compounds) of the outermost surface layer (chapter V).

The concept of multiple ion reflection from surface structures is developed step by step, starting from an ideal, flat surface. Calculations have been performed on chain-type models of surface structures believed to be present on a clean (100)-Cu single crystal surface. By carefully studying the multiple reflection energy spectra when the angle of incidence ψ is varied at a constant scattering angle θ, many different multiple reflection peaks can be resolved and identified. Good agreement has been found between the calculated E-ψ relationships for surface steps and the experimentally observed E-ψ dependence of three multiple reflection peaks (D, E and F). It is shown that more complicated surface structures, that give rise to different E-ψ curves, can be analyzed provided that a theory of zig-zag collisions is developed, which enables the identification of these collisions.

A simplified charge exchange model for multiple reflection from a surface step is proposed. This model takes into account both the neutralization and ionization probabilities in a multiple collision sequence containing one "violent" collision among a series of weak collisions.

Multiple ion reflection and mass analysis of secondary ions have been used for the characterization of a (100)-NaCl surface before and after vapour deposition of Cu. Impurities believed to originate from the reaction with water and carbon dioxide from the atmosphere disturb the periodic surface structure which results in a high background in the multiple reflection spectra. This imposes limitations on the identification of surface structures. Despite these limitations some conclusions can be drawn bearing significance with respect to the influence of surface conditions on nucleation and growth of a Cu deposit on a cleavage plane of NaCl.

Combination of mass analysis of secondary ions, single ion reflection and multiple ion reflection in one relatively simple UHV-apparatus is introduced as a new technique for surface analysis. It is shown that especially for surface composition analysis, this ion probe technique has important advantages with respect to Auger-LEED, hitherto the only known technique capable of characterizing both the composition and atomic structure of practical surfaces in one UHV-apparatus. The ultimate sensitivity for surface composition analysis with an ion probe appears to be better than for Auger by several orders of magnitude, while the possibility to analyse surface compounds is still a unique feature of this ion probe technique.