ELSEVIER

Nuclear Instruments and Methods in Physics Research B 187 (2002) 238–248

NIM B
Beam Interactions with Materials & Atoms

www.elsevier.com/locate/nimb

Production of bare argon, manganese, iron and nickel nuclei in the Dresden EBIT

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Received 31 July 2001; received in revised form 11 September 2001

Abstract

The production of highly charged argon, manganese, iron and nickel ions in a room-temperature electron beam ion trap (EBIT), the Dresden EBIT, has been investigated by means of energy dispersive X-ray spectroscopy of the direct excitation (DE) and radiative recombination (RR) processes. To derive the charge state distributions of the ions in the trap, direct excitation and radiative recombination cross-sections were calculated at electron energies of 8 and 14.4 keV. Based on these theoretical cross-sections and the measured X-ray spectra, the ion densities and the absolute number of ions, which are trapped in the electron beam, are determined for argon, manganese, iron and nickel. Emphasis has been paid to the highly charged ions, including the helium-like and hydrogen-like ions and bare nuclei. In the case of iron we also determined the contributions from lower ionization stages from DE transition lines. It is shown, that in the Dresden EBIT elements at least up to nickel can be fully ionized. Beside energy dispersive spectroscopy it is shown for iron by wavelength dispersive X-ray spectroscopy that with a comparably high gas pressure in the order of 10^{-8} mbar carbon-, boron-, beryllium-, lithium- and helium-like iron ions can be produced.