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**AUSTRALIAN ATOMIC ENERGY COMMISSION
RESEARCH ESTABLISHMENT**

LUCAS HEIGHTS RESEARCH LABORATORIES

**SPUTLIB II — A REVISED VERSION OF THE
MAXWELLIAN-AVERAGED RATES OF SPUTTERING**

by

J.L. COOK

E.K. ROSE

FEBRUARY 1986

ISBN 0 642 59824 X

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ABSTRACT

The average sputtering rate over an incidental Maxwellian distribution is tabulated as a function of temperature in the ADL-1 format.

National Library of Australia card number and ISBN 0 642 59824 X

The following descriptors have been selected from the INIS Thesaurus to describe the subject content of this report for information retrieval purposes. For further details please refer to IAEA-INIS-12 (INIS: Manual for Indexing) and IAEA-INIS-13 (INIS: Thesaurus) published in Vienna by the International Atomic Energy Agency.

BOLTZMANN STATISTICS; COMPILED DATA; DEPOSITION; DEUTERON BEAMS; EV RANGE 10-100; EV RANGE 100-1000; ENERGY DEPENDENCE; HELIUM 4 BEAMS; KEV RANGE; METALS; PLASMA; PROTON BEAMS; SCALING LAWS; SPUTTERING; SUBLIMATION HEAT; TEMPERATURE DEPENDENCE

CONTENTS

1. INTRODUCTION	1
2. SPUTTERING RATES	1
3. REFERENCES	1
Figure 1 S(T) for beryllium	3
Figure 2 S(T) for carbon	3
Figure 3 S(T) for aluminium	4
Figure 4 S(T) for silicon	4
Figure 5 S(T) for scandium	5
Figure 6 S(T) for titanium	5
Figure 7 S(T) for vanadium	6
Figure 8 S(T) for chromium	6
Figure 9 S(T) for iron	7
Figure 10 S(T) for cobalt	7
Figure 11 S(T) for nickel	8
Figure 12 S(T) for copper	8
Figure 13 S(T) for zinc	9
Figure 14 S(T) for zirconium	
Figure 15 S(T) for niobium	10
Figure 16 S(T) for molybdenum	10
Figure 17 S(T) for rhenium	11
Figure 18 S(T) for silver	11
Figure 19 S(T) for tantalum	12
Figure 20 S(T) for tungsten	
Figure 21 S(T) for gold	13
Appendix A Angular dependent sputtering coefficient library — March 1985	15

1. INTRODUCTION

Fusion reactor performance depends upon the rate of impurity injection into a plasma. This in turn has some effect upon the lifetime of the wall or limiter, and the rate at which radiation power is lost owing to the presence of impurities.

In a previous data library [Cook and Rose 1981], the Maxwellian-averaged rate of sputtering was tabulated and made available in magnetic tape form. It has since been added to the atomic data library ADL-1 [Clancy, Cook and Rose 1981]. However, since that time, new experimental information has become available on the angular distribution of sputtering coefficients [Cooke and Rose 1985] and this affects the Maxwellian-averaged coefficient quite considerably. The present report gives an updated version of the sputtering rates for twenty-one target materials, together with the laws governing the extrapolation procedure.

2. SPUTTERING RATES

The law found for the sputtering rate of a material with incident ions of mass m_1 and wall material of molecular mass m_2 are [Cook and Rose 1985]

$$S(E, \theta) = A(m_1, m_2) \left\{ \frac{E - E_T}{(E + B)^2} \right\} t^2 e^{-\beta(t-1)} \quad (1)$$

where E is the energy of the incident ion, E_T is the threshold for sputtering

$$= E_s / (\gamma(1-\gamma)), \text{ where } \gamma = \frac{4m_1 m_2}{(m_1 + m_2)^2} \quad ,$$

E_s is the sublimation energy = $0.0345L_H$, L_H is the latent heat of sublimation, $t = 1/\cos \theta$, and θ is the angle of emission of the outgoing ion.

The Maxwellian-averaged sputtering coefficient is

$$S(T) = \frac{1}{\sqrt{2\pi}} T^{-3/2} \int_{E_T}^{\infty} dE \int_0^{\pi/2} d\theta S(E, \theta) E^h e^{-E/T} \quad .$$

The scaling coefficient $A(m_1, m_2)$ is

$$\begin{aligned} A(m_1, m_2) &= A(m_1) \exp(m_2 - 1) \\ &= \exp(C_0 + C_1 m_1) \quad , \\ C_0 &= -11.393, \quad C_1 = 0.15362 \text{ for } 22 \leq Z_1 \leq 29 \quad , \\ C_0 &= -18.187, \quad C_1 = 0.15362 \text{ for } 41 \leq Z_1 \leq 47, \text{ and} \\ C_0 &= -31.409, \quad C_1 = 0.15362 \text{ for } 74 \leq Z_1 \leq 79. \end{aligned}$$

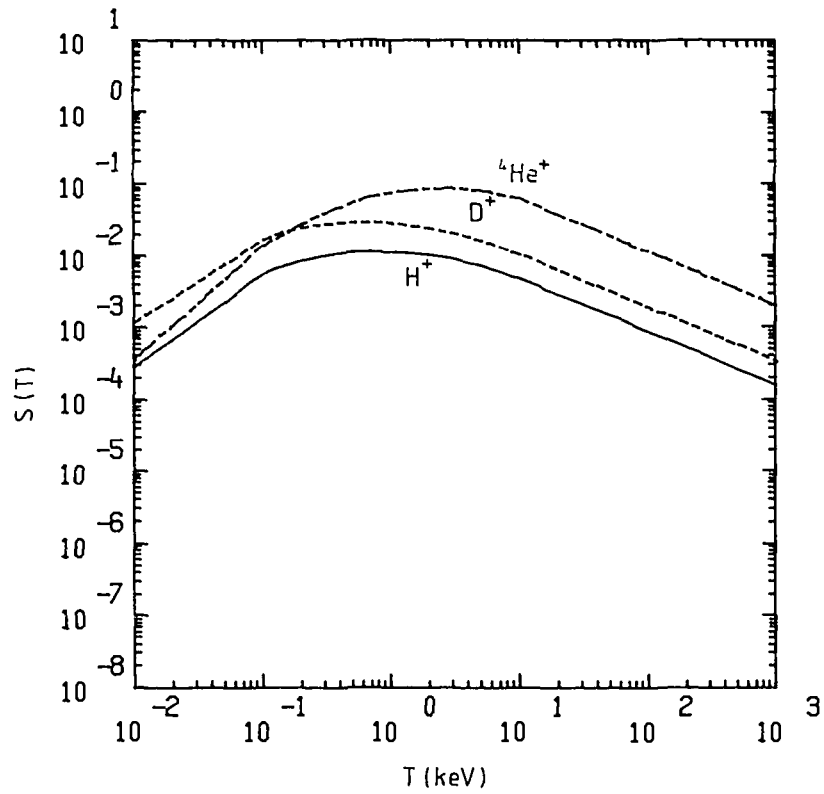
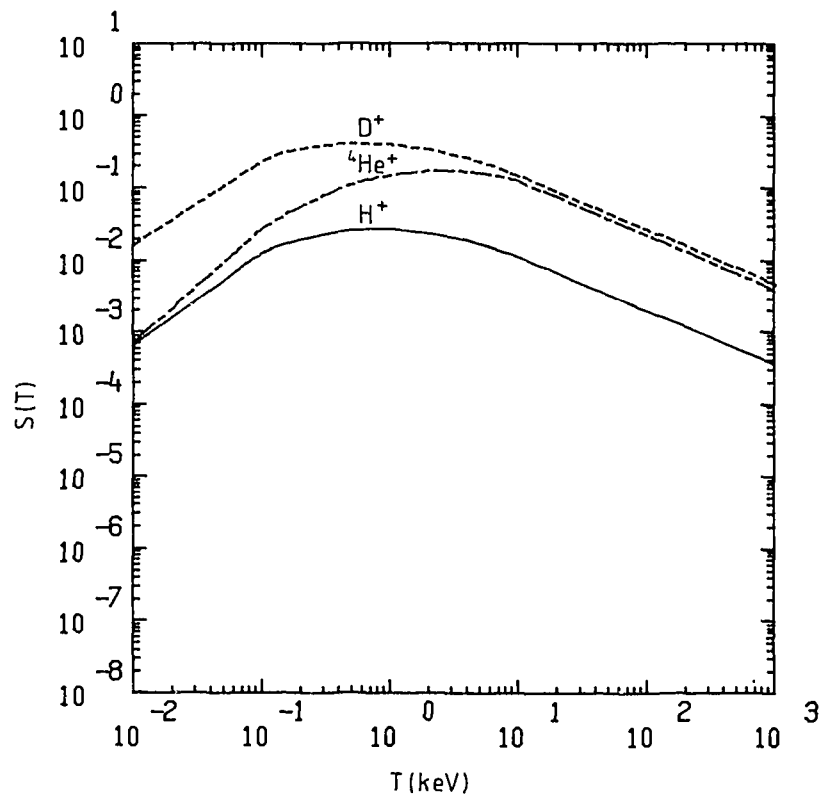
The constant value of β in equation (1) is $\beta = N\sigma R_0$; $R_0 = N^{-1/3}$ where R_0 is the average lattice spacing; σ = the microscopic absorption cross section; N is the number density = $\rho N_0/m_2$; ρ is the density of the wall and N_0 is Avogadro's number. The average over angle is

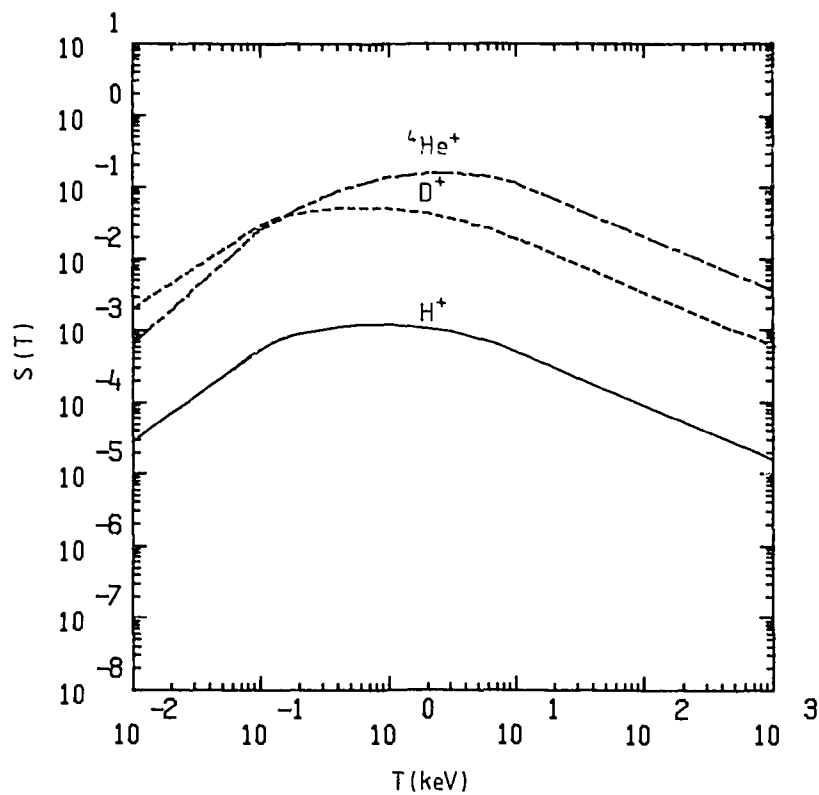
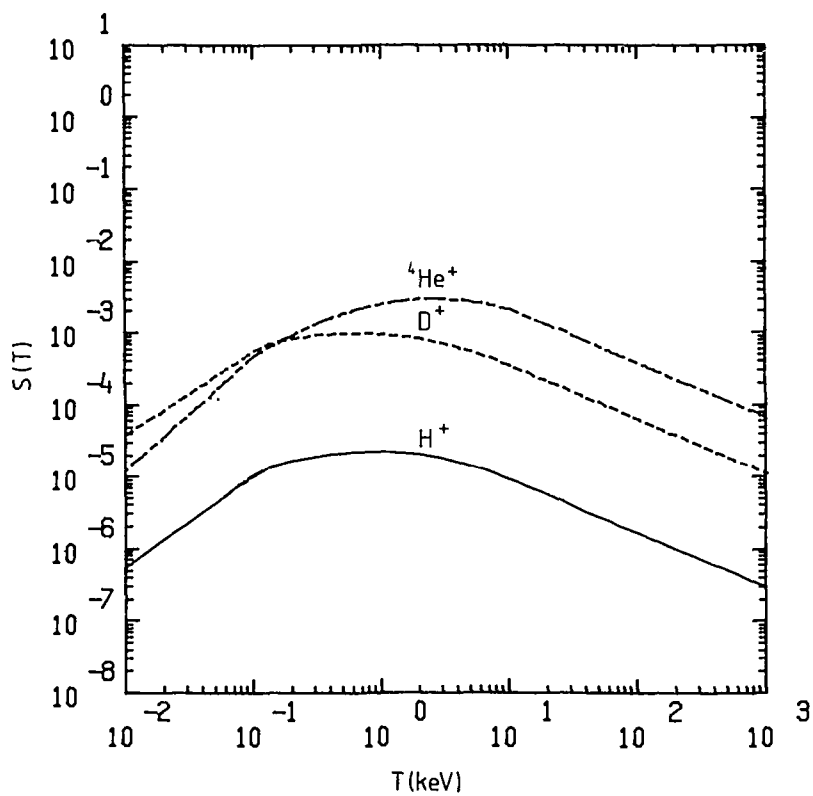
$$S(E) = \frac{1}{\beta} S(E, 0) \quad . \quad (2)$$

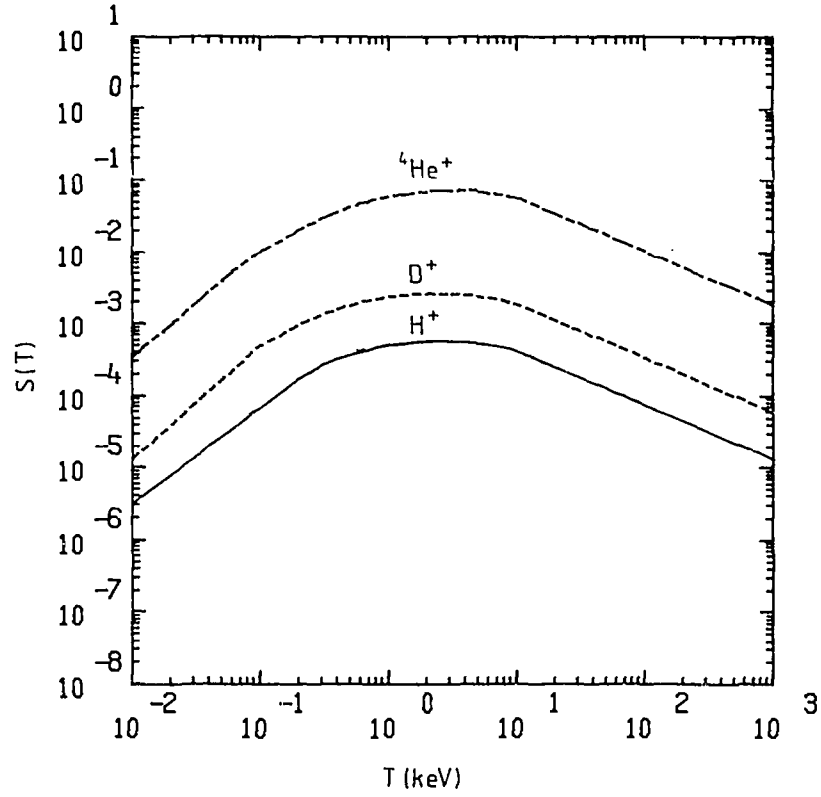
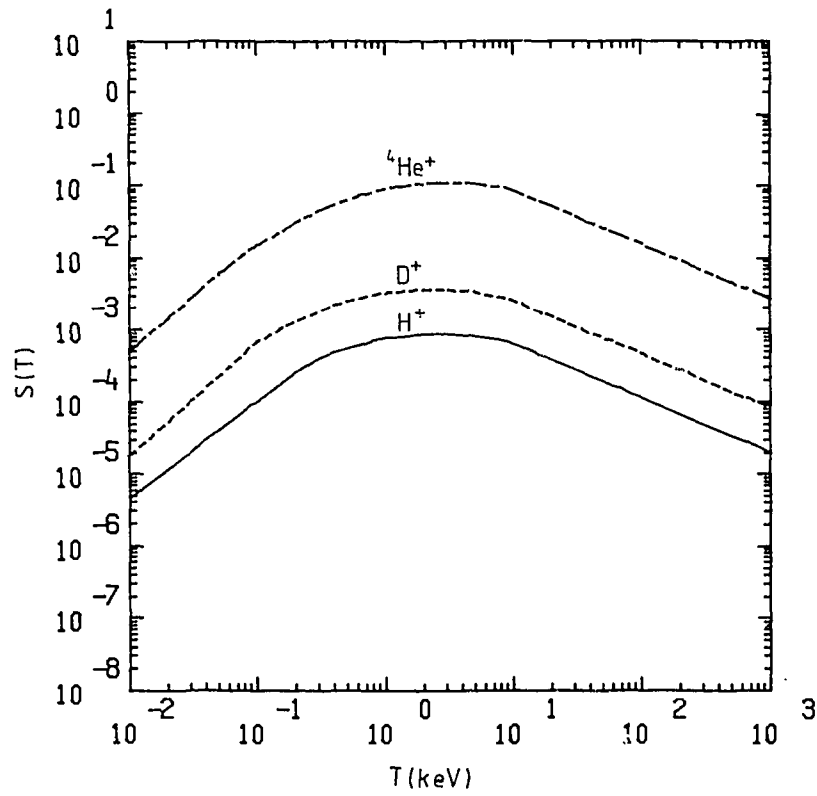
The integral (1) was evaluated both numerically and analytically and the agreement was seen to be good. The resulting coefficients are plotted in figures 1 to 21. Tables of these values are given in Appendix A together with temperatures in the ADL-1 format. It must be remembered that if T is the plasma temperature at the wall then, owing to the existence of a surface electrical sheath, the ions are accelerated to an effective temperature of $3T$; this must be used when referring to the tables. The nuclides covered are Be, C, Al, Si, Sc, Ti, V, Cr, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, Rh, Ag, Ta, W and Au.

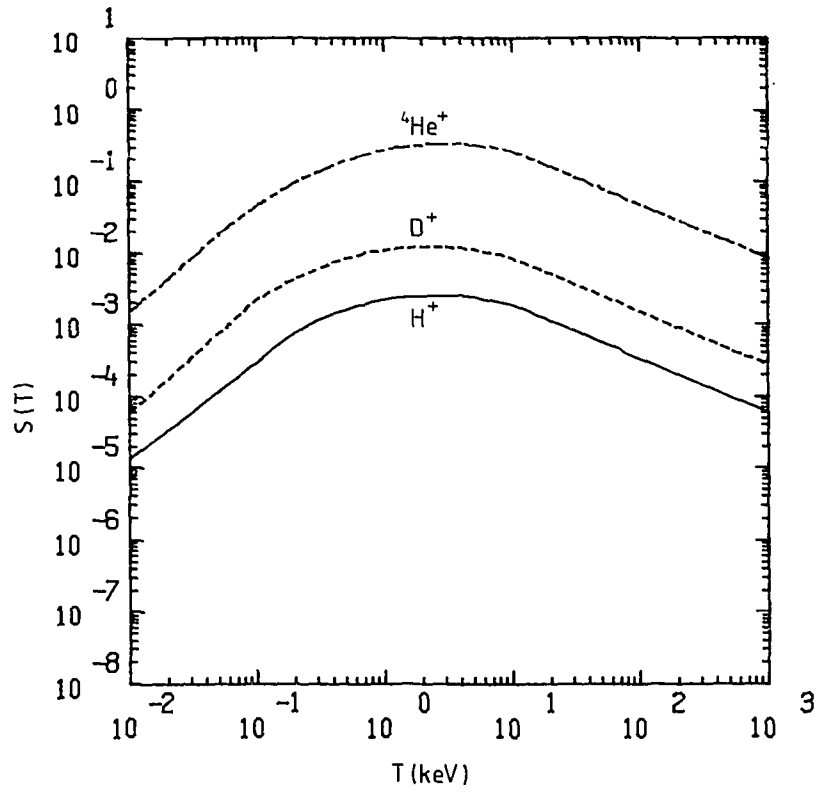
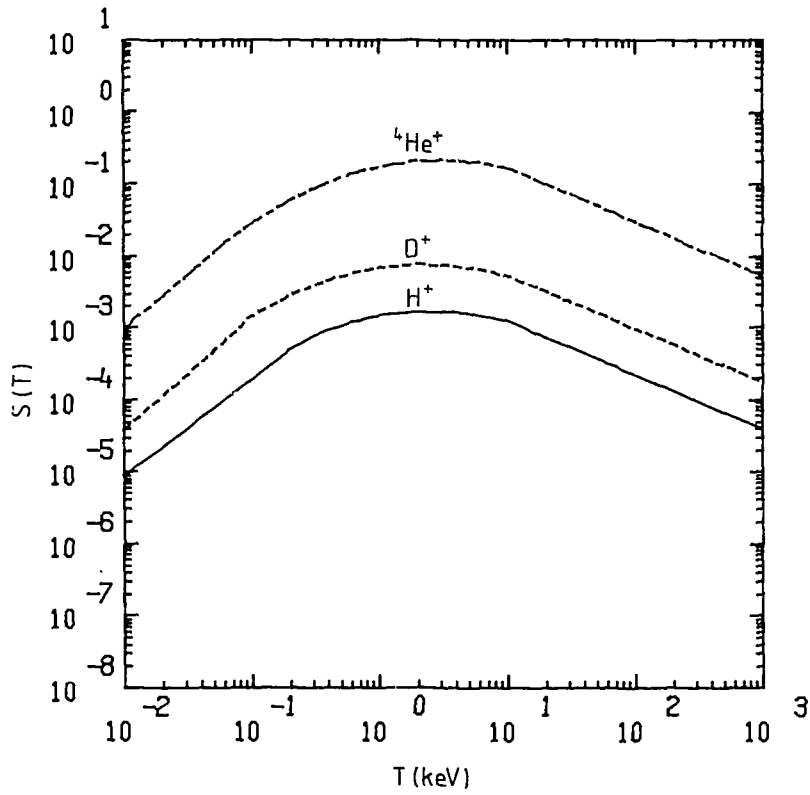
3. REFERENCES

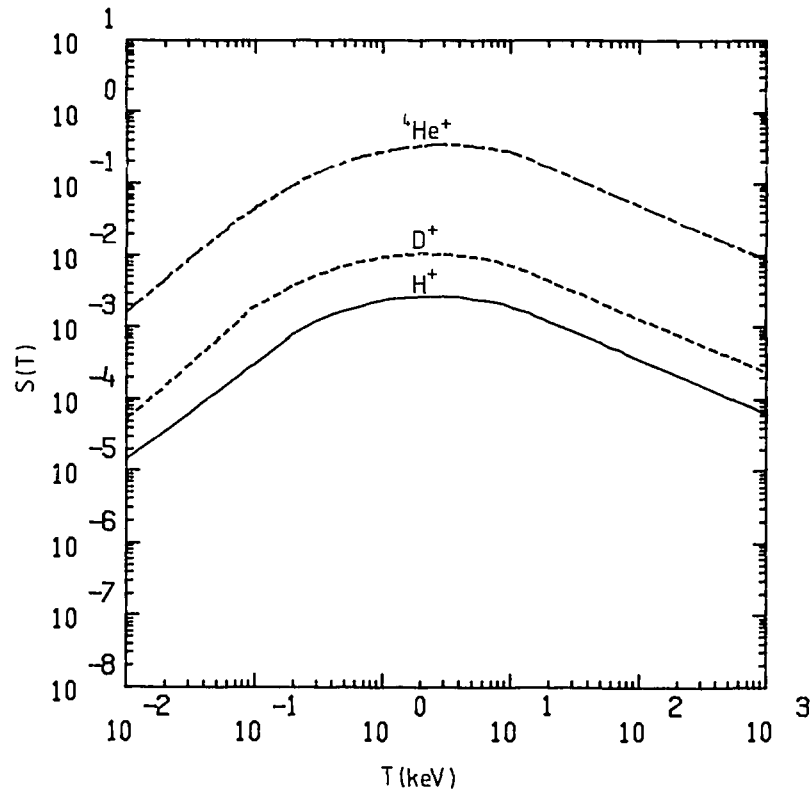
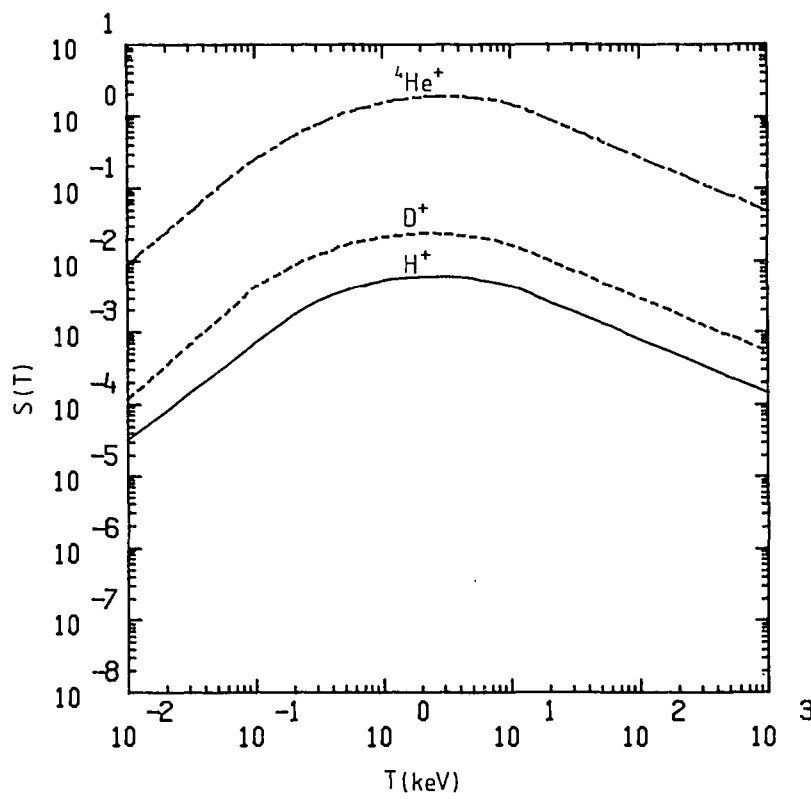
- Cook, J.L. and Rose, E.K. [1981] - SPUTLIB - a library of Maxwellian - averaged sputtering coefficients. AAEC/E541.
- Clancy, B.E., Cook, J.L. and Rose, E.K. [1981] - ADL-1 : An atomic data library for the use in computing the behaviour of plasma devices, including fusion reactors. AAEC/E515.
- Cook, J.L. and Rose E.K. [1985] - The effect of the angular dependence of sputtering in fusion reactors. *Aust. J. Phys.*, 38:623-31.

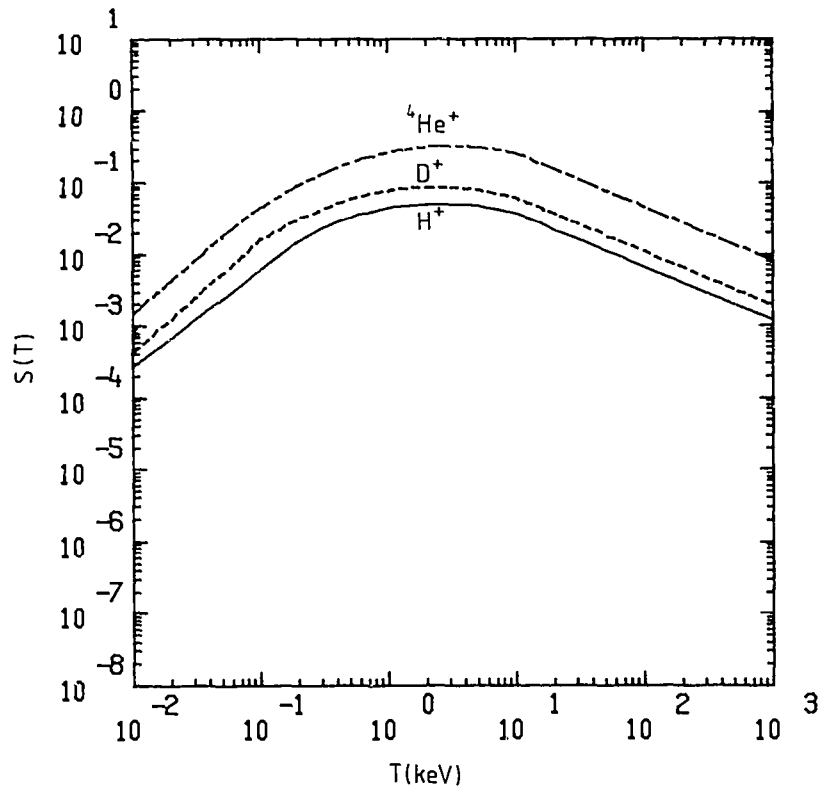
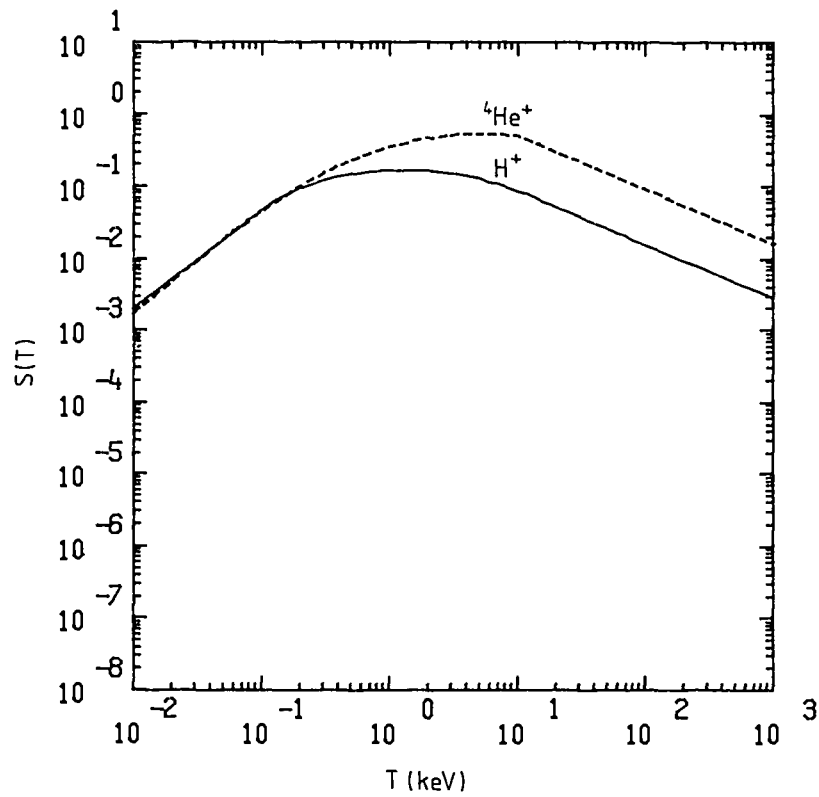
Figure 1 $S(T)$ for berylliumFigure 2 $S(T)$ for carbon

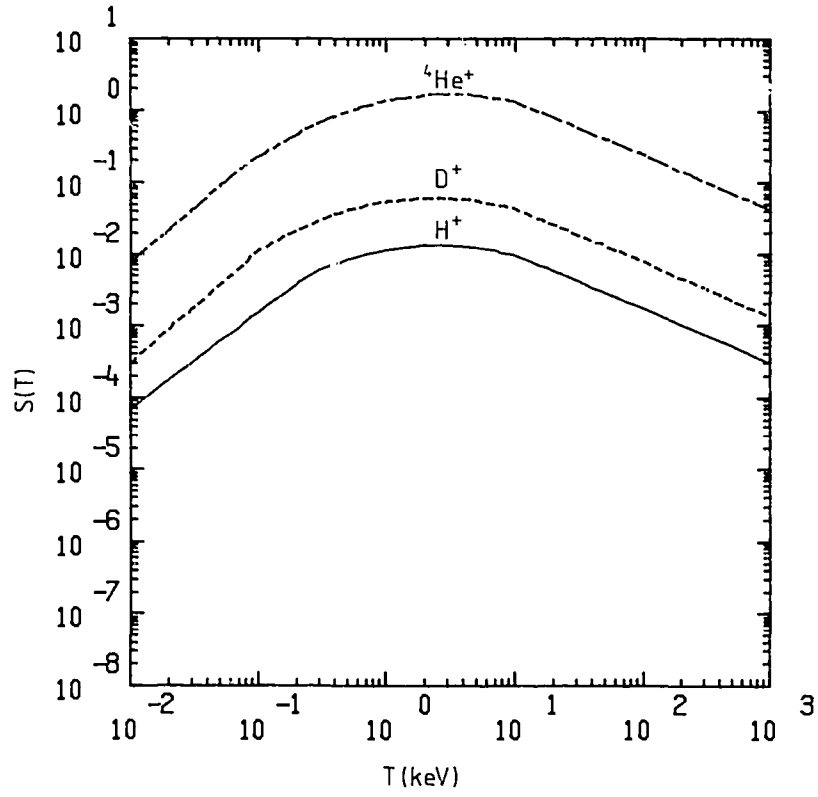
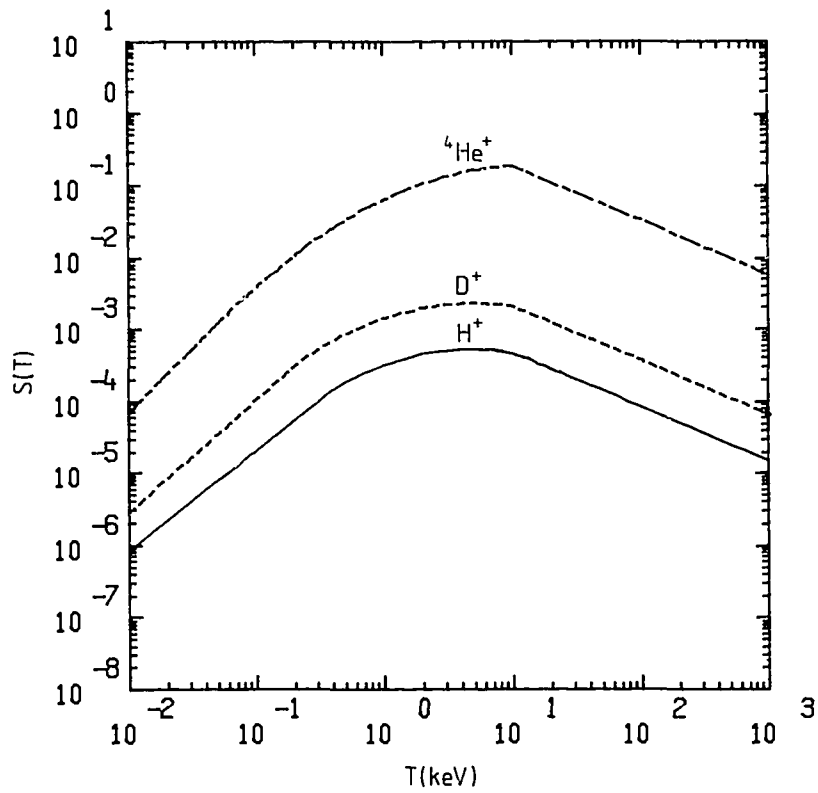
Figure 3 $S(T)$ for aluminiumFigure 4 $S(T)$ for silicon

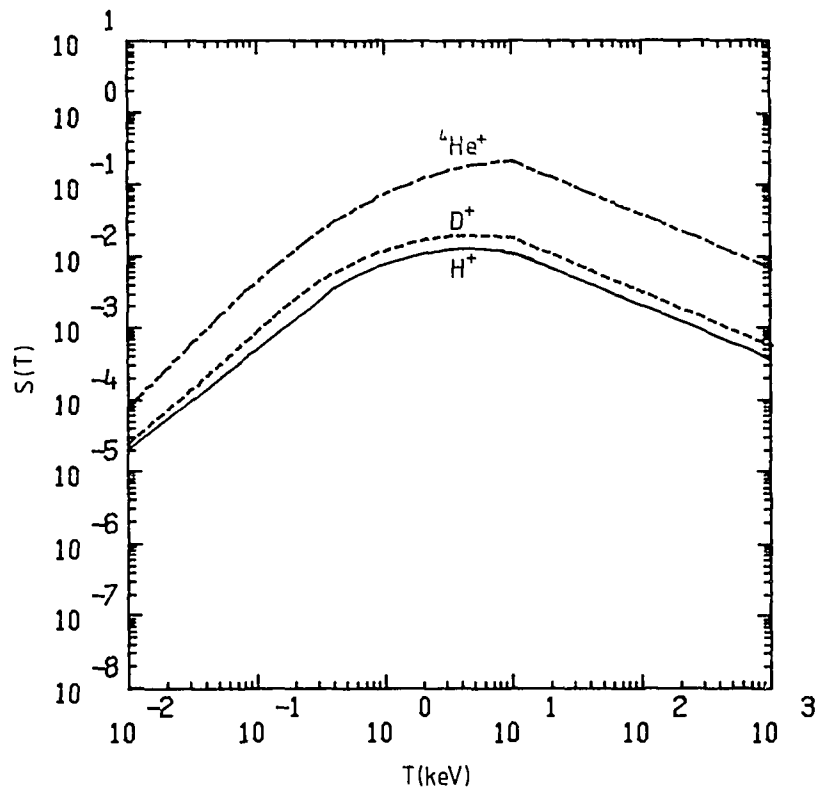
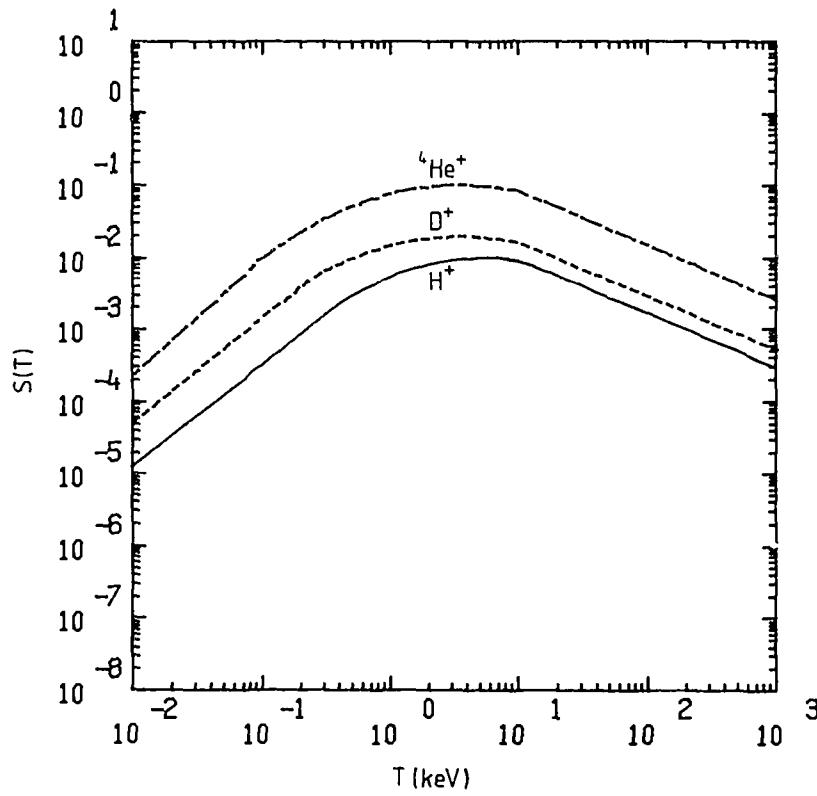
Figure 5 $S(T)$ for scandiumFigure 6 $S(T)$ for titanium

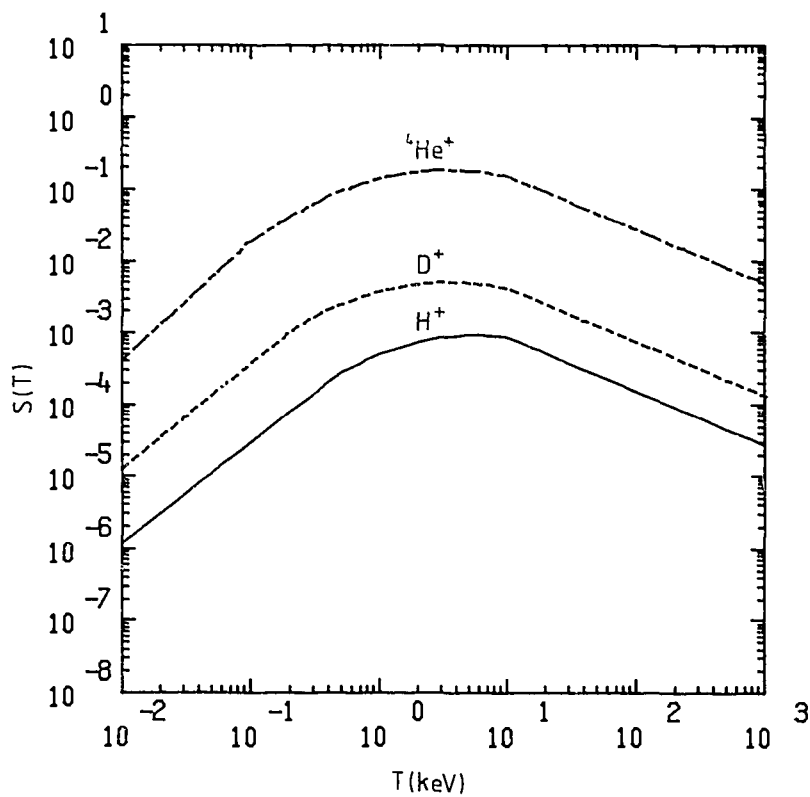
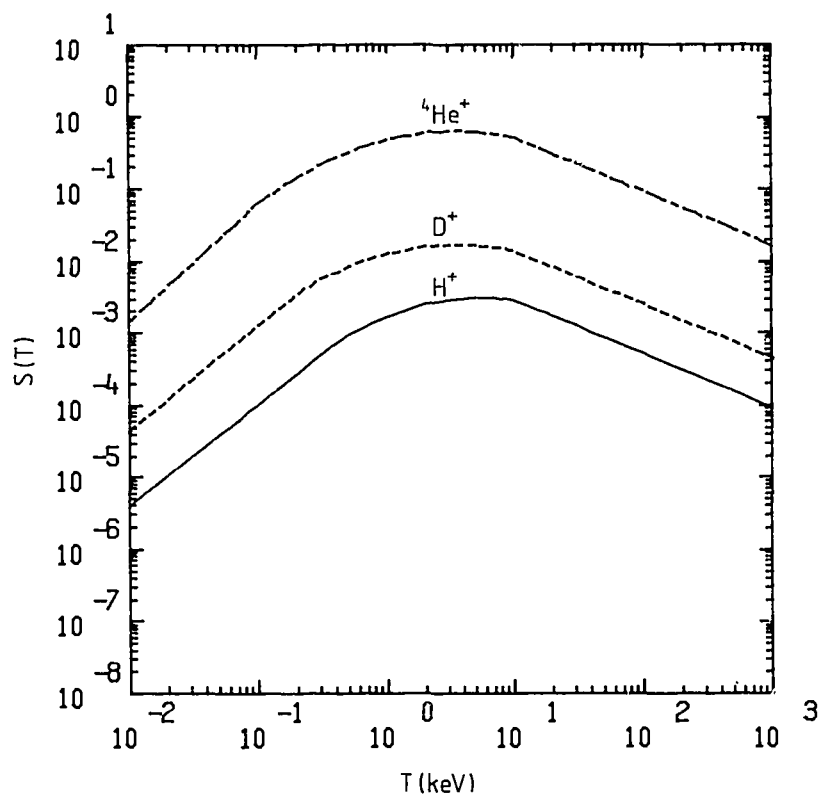
Figure 7 $S(T)$ for vanadiumFigure 8 $S(T)$ for chromium

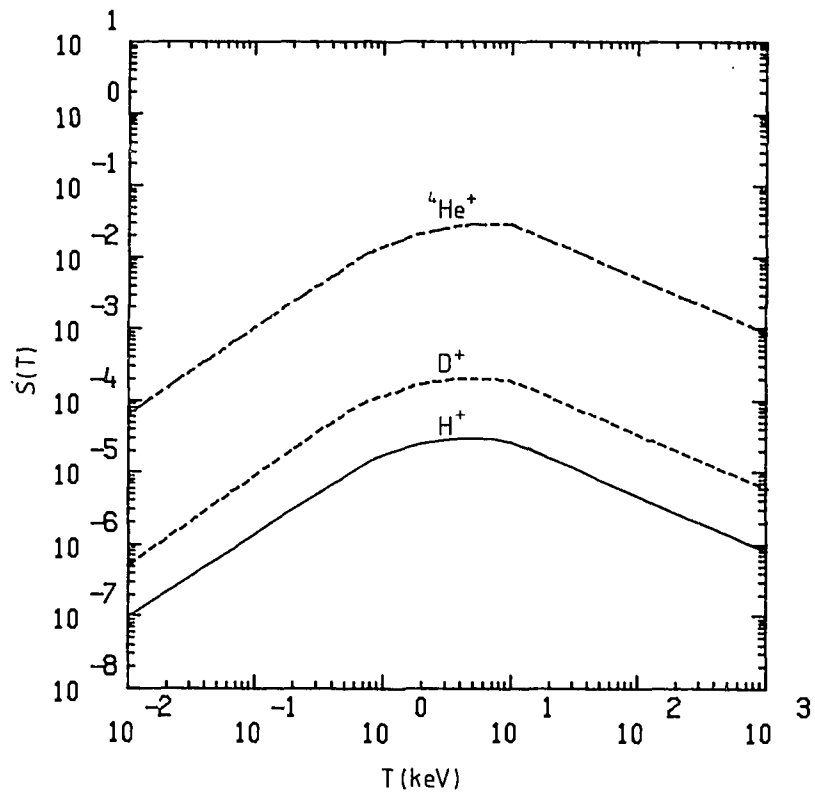
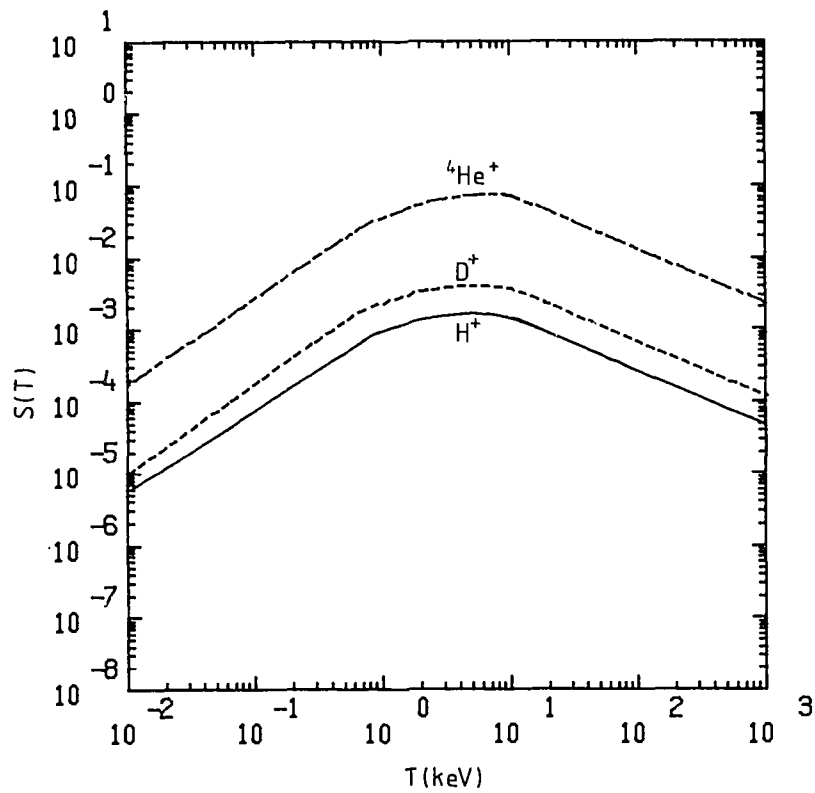
Figure 9 $S(T)$ for ironFigure 10 $S(T)$ for cobalt

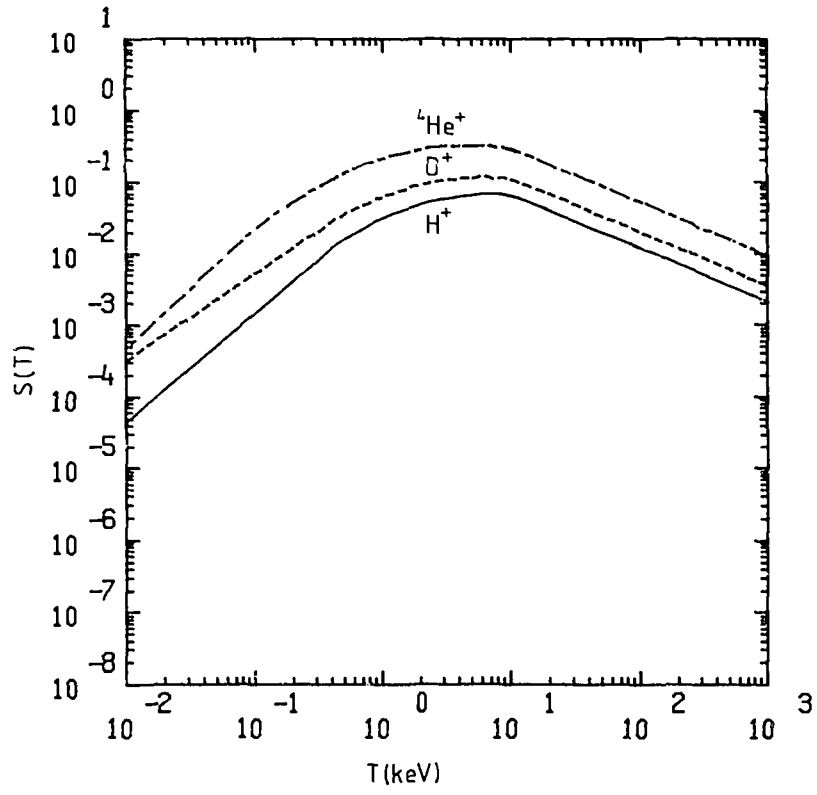
Figure 11 $S(T)$ for nickelFigure 12 $S(T)$ for copper

Figure 13 $S(T)$ for zincFigure 14 $S(T)$ for zirconium

Figure 15 $S(T)$ for niobiumFigure 16 $S(T)$ for molybdenum

Figure 17 $S(T)$ for rheniumFigure 18 $S(T)$ for silver

Figure 19 $S(T)$ for tantalumFigure 20 $S(T)$ for tungsten

Figure 21 $S(T)$ for gold

APPENDIX A

Angular dependent sputtering coefficient library — March 1985

* TEMPERATURES IN KEY (45 ENTRIES)

*

1.000E-02	2.000E-02	3.000E-02	4.000E-02	5.000E-02	6.000E-02	7.000E-02
8.000E-02	9.000E-02	1.000E-01	2.000E-01	3.000E-01	4.000E-01	5.000E-01
6.000E-01	7.000E-01	8.000E-01	9.000E-01	1.000E+00	2.000E+00	3.000E+00
4.000E+00	5.000E+00	6.000E+00	7.000E+00	8.000E+00	9.000E+00	1.000E+01
1.200E+01	1.400E+01	1.600E+01	1.800E+01	2.000E+01	3.000E+01	4.000E+01
5.000E+01	6.000E+01	7.000E+01	8.000E+01	9.000E+01	1.000E+02	2.500E+02
5.000E+02	7.500E+02	1.000E+03				

* ANG-DEP. SPUTTERING COEFFT FOR BE H+

*

2.760E-04	6.777E-04	1.146E-03	1.664E-03	2.222E-03	2.814E-03	3.437E-03
4.086E-03	5.513E-03	5.894E-03	8.444E-03	9.774E-03	1.054E-02	1.099E-02
1.125E-02	1.139E-02	1.145E-02	1.145E-02	1.141E-02	1.033E-02	9.136E-03
8.137E-03	7.318E-03	6.638E-03	6.068E-03	5.583E-03	5.165E-03	4.802E-03
4.249E-03	3.785E-03	3.425E-03	3.135E-03	2.897E-03	2.137E-03	1.723E-03
1.457E-03	1.271E-03	1.132E-03	1.024E-03	9.376E-04	8.664E-04	4.358E-04
2.591E-04	1.912E-04	1.541E-04				

* ANG-DEP. SPUTTERING COEFFT FOR BE D+

*

1.143E-03	2.539E-03	4.051E-03	5.643E-03	7.297E-03	9.003E-03	1.075E-02
1.254E-02	1.436E-02	1.622E-02	2.453E-02	2.699E-02	2.815E-02	2.865E-02
2.879E-02	2.870E-02	2.849E-02	2.819E-02	2.784E-02	2.336E-02	2.056E-02
1.803E-02	1.604E-02	1.443E-02	1.311E-02	1.201E-02	1.107E-02	1.026E-02
9.087E-03	8.095E-03	7.323E-03	6.704E-03	6.195E-03	4.570E-03	3.683E-03
3.116E-03	2.713E-03	2.421E-03	2.180E-03	2.005E-03	1.853E-03	3.315E-04
5.541E-04	4.088E-04	3.295E-04				

* ANG-DEP. SPUTTERING COEFFT FOR BE 4HE+

*

3.571E-04	1.068E-03	2.026E-03	3.192E-03	4.541E-03	6.057E-03	7.727E-03
9.542E-03	1.190E-02	1.345E-02	2.732E-02	3.822E-02	4.681E-02	5.370E-02
5.929E-02	6.338E-02	6.767E-02	7.084E-02	7.349E-02	8.485E-02	8.529E-02
8.264E-02	7.903E-02	7.520E-02	7.146E-02	6.790E-02	6.457E-02	6.147E-02
5.402E-02	4.813E-02	4.354E-02	3.986E-02	3.683E-02	2.717E-02	2.190E-02
1.852E-02	1.616E-02	1.439E-02	1.302E-02	1.192E-02	1.101E-02	5.540E-03
3.284E-03	2.430E-03	1.959E-03				

* ANG-DEP. SPUTTERING COEFFT FOR C H+

*

6.366E-04	1.563E-03	2.644E-03	3.839E-03	5.126E-03	6.492E-03	7.925E-03
9.425E-03	1.272E-02	1.360E-02	1.948E-02	2.255E-02	2.430E-02	2.534E-02
2.594E-02	2.627E-02	2.640E-02	2.641E-02	2.633E-02	2.382E-02	2.107E-02
1.877E-02	1.688E-02	1.531E-02	1.400E-02	1.285E-02	1.191E-02	1.103E-02
9.802E-03	8.732E-03	7.900E-03	7.232E-03	6.683E-03	4.930E-03	3.973E-03
3.361E-03	2.932E-03	2.612E-03	2.363E-03	2.163E-03	1.999E-03	1.005E-03
5.977E-04	4.410E-04	3.554E-04				

* ANG-DEP. SPUTTERING COEFFT FOR C D+

*

1.621E-02	3.602E-02	5.747E-02	8.005E-02	1.035E-01	1.277E-01	1.525E-01
1.779E-01	2.037E-01	2.300E-01	3.479E-01	3.829E-01	3.993E-01	4.064E-01
4.083E-01	4.071E-01	4.041E-01	3.999E-01	3.949E-01	3.384E-01	2.917E-01
2.557E-01	2.275E-01	2.047E-01	1.360E-01	1.793E-01	1.570E-01	1.455E-01
1.289E-01	1.148E-01	1.039E-01	9.509E-02	8.787E-02	6.483E-02	5.225E-02
4.420E-02	3.855E-02	3.434E-02	3.107E-02	2.844E-02	2.628E-02	1.322E-02
7.859E-03	5.798E-03	4.673E-03				

* ANG-DEP. SPUTTERING COEFFT FOR C 4HE+

*

7.074E-04	2.115E-03	4.013E-03	6.323E-03	8.995E-03	1.200E-02	1.531E-02
1.890E-02	2.357E-02	2.664E-02	5.412E-02	7.571E-02	9.274E-02	1.064E-01
1.174E-01	1.265E-01	1.341E-01	1.403E-01	1.456E-01	1.681E-01	1.690E-01
1.637E-01	1.566E-01	1.490E-01	1.416E-01	1.345E-01	1.279E-01	1.218E-01
1.070E-01	9.534E-02	8.625E-02	7.896E-02	7.296E-02	5.383E-02	4.338E-02
3.670E-02	3.201E-02	2.851E-02	2.579E-02	2.361E-02	2.182E-02	1.097E-02
6.526E-03	4.815E-03	3.880E-03				

* ANG-DEP. SPUTTERING COEFFT FOR AL H+

*

2.867E-05	7.039E-05	1.191E-04	1.728E-04	2.308E-04	2.923E-04	3.570E-04
4.244E-04	5.727E-04	6.122E-04	8.772E-04	1.015E-03	1.094E-03	1.141E-03
1.168E-03	1.183E-03	1.189E-03	1.189E-03	1.186E-03	1.073E-03	9.490E-04
8.453E-04	7.601E-04	6.896E-04	6.303E-04	5.799E-04	5.365E-04	4.988E-04
4.414E-04	3.932E-04	3.557E-04	3.257E-04	3.009E-04	2.220E-04	1.789E-04
1.514E-04	1.320E-04	1.176E-04	1.064E-04	9.740E-05	8.000E-05	4.527E-05
2.691E-05	1.986E-05	1.600E-05				

* ANG-DEP. SPUTTERING COEFFT FOR AL D+

*

2.038E-03	4.528E-03	7.224E-03	1.006E-02	1.301E-02	1.605E-02	1.917E-02
2.236E-02	2.561E-02	2.891E-02	4.373E-02	4.813E-02	5.019E-02	5.108E-02
5.132E-02	5.118E-02	5.080E-02	5.027E-02	4.965E-02	4.254E-02	3.666E-02
3.214E-02	2.859E-02	2.573E-02	2.338E-02	2.141E-02	1.974E-02	1.829E-02
1.620E-02	1.443E-02	1.306E-02	1.195E-02	1.104E-02	8.149E-03	6.567E-03
5.555E-03	4.845E-03	4.316E-03	3.905E-03	3.575E-03	3.303E-03	1.661E-03
9.879E-04	7.289E-04	5.874E-04				

* ANG-DEP. SPUTTERING COEFFT FOR AL 4HE+

*

6.525E-04	1.951E-03	3.702E-03	5.333E-03	8.298E-03	1.197E-02	1.412E-02
1.744E-02	2.174E-02	2.455E-02	4.992E-02	6.984E-02	8.555E-02	9.813E-02
1.083E-01	1.167E-01	1.237E-01	1.295E-01	1.343E-01	1.551E-01	1.559E-01
1.510E-01	1.444E-01	1.374E-01	1.306E-01	1.241E-01	1.180E-01	1.123E-01
9.873E-02	8.795E-02	7.957E-02	7.284E-02	6.730E-02	4.966E-02	4.002E-02
3.385E-02	2.953E-02	2.630E-02	2.380E-02	2.178E-02	2.013E-02	1.012E-02
6.020E-03	4.441E-03	3.579E-03				

* ANG-DEP. SPUTTERING COEFFT FOR SI H+

*

5.370E-07	1.319E-06	2.230E-06	3.238E-06	4.324E-06	5.476E-06	6.687E-06
7.950E-06	1.073E-05	1.147E-05	1.643E-05	1.902E-05	2.050E-05	2.137E-05
2.188E-05	2.216E-05	2.227E-05	2.228E-05	2.221E-05	2.010E-05	1.779E-05
1.583E-05	1.424E-05	1.292E-05	1.181E-05	1.086E-05	1.005E-05	9.343E-06
8.268E-06	7.366E-06	6.664E-06	6.100E-06	5.637E-06	4.159E-06	3.352E-06
2.835E-06	2.473E-06	2.203E-06	1.993E-06	1.824E-06	1.686E-06	8.479E-07
5.042E-07	3.720E-07	2.935E-07				

* ANG-DEP. SPUTTERING COEFFT FOR SI D+

*

3.769E-05	8.375E-05	1.336E-04	1.861E-04	2.407E-04	2.969E-04	3.546E-04
4.136E-04	4.737E-04	5.348E-04	8.088E-04	8.903E-04	9.284E-04	9.449E-04
9.493E-04	9.466E-04	9.396E-04	9.298E-04	9.183E-04	7.869E-04	6.781E-04
5.945E-04	5.283E-04	4.760E-04	4.325E-04	3.960E-04	3.650E-04	3.383E-04
2.997E-04	2.669E-04	2.415E-04	2.211E-04	2.043E-04	1.507E-04	1.215E-04
1.028E-04	8.962E-05	7.984E-05	7.223E-05	6.612E-05	6.110E-05	3.073E-05
1.827E-05	1.348E-05	1.086E-05				

* ANG-DEP. SPUTTERING COEFFT FOR SI 4HE+

*

1.202E-05	3.593E-05	6.818E-05	1.074E-04	1.528E-04	2.039E-04	2.601E-04
3.212E-04	4.004E-04	4.526E-04	9.195E-04	1.286E-03	1.576E-03	1.807E-03
1.995E-03	2.150E-03	2.278E-03	2.384E-03	2.473E-03	2.856E-03	2.871E-03
2.781E-03	2.660E-03	2.531E-03	2.405E-03	2.285E-03	2.173E-03	2.069E-03
1.818E-03	1.620E-03	1.465E-03	1.341E-03	1.240E-03	9.145E-04	7.371E-04
6.235E-04	5.438E-04	4.844E-04	4.383E-04	4.012E-04	3.707E-04	1.865E-04
1.109E-04	8.189E-05	6.592E-05				

* ANG-DEP. SPUTTERING COEFFT FOR SC H+

*

3.011E-06	7.638E-06	1.317E-05	1.938E-05	2.615E-05	3.340E-05	4.108E-05
4.915E-05	5.758E-05	6.633E-05	1.683E-04	2.556E-04	3.129E-04	3.588E-04
3.960E-04	4.266E-04	4.520E-04	4.731E-04	4.908E-04	5.669E-04	5.703E-04
5.529E-04	5.291E-04	5.038E-04	4.799E-04	4.554E-04	4.333E-04	4.127E-04
3.650E-04	3.252E-04	2.942E-04	2.693E-04	2.488E-04	1.836E-04	1.480E-04
1.252E-04	1.092E-04	9.724E-05	8.798E-05	8.054E-05	7.442E-05	3.743E-05
2.226E-05	1.642E-05	1.323E-05				

* ANG-DEP. SPUTTERING COEFFT FOR SC D+

*

1.289E-05	3.823E-05	7.223E-05	1.134E-04	1.610E-04	2.143E-04	2.730E-04
3.366E-04	4.329E-04	4.852E-04	9.463E-04	1.291E-03	1.561E-03	1.770E-03
1.937E-03	2.071E-03	2.180E-03	2.269E-03	2.342E-03	2.621E-03	2.591E-03
2.482E-03	2.353E-03	2.224E-03	2.102E-03	1.938E-03	1.833E-03	1.786E-03
1.579E-03	1.406E-03	1.272E-03	1.165E-03	1.076E-03	7.940E-04	6.399E-04
5.413E-04	4.721E-04	4.206E-04	3.805E-04	3.483E-04	3.219E-04	1.619E-04
9.626E-05	7.102E-05	5.723E-05				

* ANG-DEP. SPUTTERING COEFFT FOR SC 4HE+

*

3.346E-04	9.603E-04	1.779E-03	2.756E-03	3.869E-03	5.106E-03	6.228E-03
7.387E-03	8.543E-03	9.690E-03	2.017E-02	2.868E-02	3.556E-02	4.120E-02
4.587E-02	4.979E-02	5.309E-02	5.590E-02	5.830E-02	6.987E-02	7.191E-02
7.090E-02	6.877E-02	6.621E-02	6.356E-02	6.094E-02	5.841E-02	5.602E-02
4.933E-02	4.395E-02	3.976E-02	3.640E-02	3.363E-02	2.481E-02	2.000E-02
1.692E-02	1.475E-02	1.314E-02	1.189E-02	1.088E-02	1.006E-02	5.039E-03
3.008E-03	2.219E-03	1.789E-03				

* ANG-DEP. SPUTTERING COEFFT FOR TI H+

*

4.554E-06	1.155E-05	1.991E-05	2.931E-05	3.955E-05	5.052E-05	6.214E-05
7.434E-05	8.708E-05	1.003E-04	2.545E-04	3.866E-04	4.732E-04	5.426E-04
5.990E-04	6.453E-04	6.836E-04	7.135E-04	7.423E-04	8.574E-04	8.625E-04
8.363E-04	8.003E-04	7.620E-04	7.245E-04	6.885E-04	6.553E-04	6.242E-04
5.520E-04	4.918E-04	4.449E-04	4.073E-04	3.763E-04	2.777E-04	2.238E-04
1.893E-04	1.651E-04	1.471E-04	1.331E-04	1.218E-04	1.126E-04	5.661E-05
3.366E-05	2.484E-05	2.002E-05				

* ANG-DEP. SPUTTERING COEFFT FOR TI D+

*

1.775E-05	5.266E-05	9.949E-05	1.563E-04	2.218E-04	2.952E-04	3.760E-04
4.636E-04	5.950E-04	6.683E-04	1.303E-03	1.783E-03	2.151E-03	2.438E-03
2.668E-03	2.852E-03	3.002E-03	3.125E-03	3.226E-03	3.610E-03	3.568E-03
3.418E-03	3.241E-03	3.064E-03	2.895E-03	2.738E-03	2.593E-03	2.460E-03
2.174E-03	1.937E-03	1.752E-03	1.604E-03	1.482E-03	1.094E-03	8.814E-04
7.456E-04	6.503E-04	5.793E-04	5.241E-04	4.798E-04	4.433E-04	2.230E-04
1.326E-04	9.782E-05	7.883E-05				

* ANG-DEP. SPUTTERING COEFFT FOR TI 4HE+

*

5.011E-04	1.438E-03	2.664E-03	4.127E-03	5.795E-03	7.647E-03	9.327E-03
1.106E-02	1.279E-02	1.451E-02	3.021E-02	4.295E-02	5.326E-02	6.170E-02
6.870E-02	7.456E-02	7.951E-02	8.371E-02	8.731E-02	1.046E-01	1.077E-01
1.062E-01	1.030E-01	9.816E-02	9.518E-02	9.126E-02	8.748E-02	8.389E-02
7.388E-02	6.581E-02	5.934E-02	5.451E-02	5.036E-02	3.716E-02	2.995E-02
2.533E-02	2.209E-02	1.968E-02	1.781E-02	1.630E-02	1.506E-02	7.576E-03
4.505E-03	3.324E-03	2.679E-03				

* ANG-DEP. SPUTTERING COEFFT FOR V H+

*

1.349E-05	3.422E-05	5.895E-05	8.680E-05	1.171E-04	1.486E-04	1.840E-04
2.202E-04	2.579E-04	2.971E-04	7.535E-04	1.145E-03	1.402E-03	1.607E-03
1.774E-03	1.911E-03	2.025E-03	2.119E-03	2.199E-03	2.539E-03	2.555E-03
2.477E-03	2.370E-03	2.257E-03	2.146E-03	2.040E-03	1.841E-03	1.849E-03
1.635E-03	1.457E-03	1.318E-03	1.206E-03	1.115E-03	8.224E-04	6.628E-04
5.607E-04	4.890E-04	4.356E-04	3.941E-04	3.608E-04	3.334E-04	1.677E-04
9.970E-05	7.356E-05	5.928E-05				

* ANG-DEP. SPUTTERING COEFFT FOR V D+

*

5.889E-05 1.747E-04 3.301E-04 5.184E-04 7.357E-04 9.784E-04 1.247E-03
 1.538E-03 1.974E-03 2.217E-03 4.324E-03 5.915E-03 7.135E-03 8.090E-03
 8.850E-03 9.463E-03 9.960E-03 1.037E-02 1.070E-02 1.103E-02 1.184E-02
 1.134E-02 1.075E-02 1.016E-02 9.605E-03 9.084E-03 8.604E-03 8.162E-03
 7.214E-03 6.426E-03 5.814E-03 5.322E-03 4.918E-03 3.628E-03 2.924E-03
 2.474E-03 2.157E-03 1.922E-03 1.739E-03 1.592E-03 1.471E-03 7.398E-04
 4.399E-04 3.245E-04 2.615E-04

* ANG-DEP. SPUTTERING COEFFT FOR V 4HE+

*

1.544E-03 4.431E-03 8.209E-03 1.272E-02 1.785E-02 2.356E-02 2.874E-02
 3.408E-02 3.942E-02 4.471E-02 9.308E-02 1.323E-01 1.641E-01 1.901E-01
 2.117E-01 2.297E-01 2.450E-01 2.579E-01 2.690E-01 3.224E-01 3.315E-01
 3.272E-01 3.173E-01 3.055E-01 2.933E-01 2.812E-01 2.695E-01 2.585E-01
 2.276E-01 2.028E-01 1.834E-01 1.679E-01 1.552E-01 1.145E-01 9.227E-02
 7.805E-02 6.807E-02 6.064E-02 5.486E-02 5.022E-02 4.641E-02 2.334E-02
 1.388E-02 1.024E-02 8.253E-03

* ANG-DEP. SPUTTERING COEFFT FOR CR H+

*

8.875E-06 2.251E-05 3.881E-05 5.711E-05 7.707E-05 9.845E-05 1.211E-04
 1.449E-04 1.697E-04 1.955E-04 4.960E-04 7.534E-04 9.223E-04 1.058E-03
 1.167E-03 1.258E-03 1.332E-03 1.394E-03 1.447E-03 1.671E-03 1.681E-03
 1.630E-03 1.560E-03 1.485E-03 1.412E-03 1.342E-03 1.277E-03 1.216E-03
 1.076E-03 9.584E-04 8.671E-04 7.938E-04 7.335E-04 5.411E-04 4.361E-04
 3.689E-04 3.218E-04 2.866E-04 2.583E-04 2.374E-04 2.194E-04 1.103E-04
 6.560E-05 4.840E-05 3.901E-05

* ANG-DEP. SPUTTERING COEFFT FOR CP D+

*

3.800E-05 1.128E-04 2.130E-04 3.346E-04 4.748E-04 6.320E-04 8.050E-04
 9.926E-04 1.274E-03 1.431E-03 2.791E-03 3.817E-03 4.605E-03 5.221E-03
 5.711E-03 6.107E-03 6.428E-03 6.691E-03 6.936E-03 7.729E-03 7.640E-03
 7.318E-03 6.939E-03 6.559E-03 6.193E-03 5.862E-03 5.552E-03 5.267E-03
 4.655E-03 4.147E-03 3.752E-03 3.435E-03 3.174E-03 2.342E-03 1.887E-03
 1.596E-03 1.392E-03 1.240E-03 1.122E-03 1.027E-03 9.492E-04 4.774E-04
 2.839E-04 2.094E-04 1.688E-04

* ANG-DEP. SPUTTERING COEFFT FOR CR 4HE+

*
 9.865E-04 2.871E-03 5.246E-03 8.125E-03 1.141E-02 1.505E-02 1.836E-02
 2.178E-02 2.519E-02 2.857E-02 5.948E-02 8.455E-02 1.048E-01 1.215E-01
 1.352E-01 1.468E-01 1.565E-01 1.648E-01 1.719E-01 2.060E-01 2.120E-01
 2.091E-01 2.027E-01 1.952E-01 1.874E-01 1.797E-01 1.722E-01 1.652E-01
 1.454E-01 1.296E-01 1.172E-01 1.073E-01 9.916E-02 7.316E-02 5.996E-02
 4.987E-02 4.150E-02 3.875E-02 3.506E-02 3.209E-02 2.965E-02 1.402E-02
 8.869E-03 6.543E-03 5.273E-03

* ANG-DEP. SPUTTERING COEFFT FOR FE H+

*
 1.397E-05 3.543E-05 6.108E-05 8.988E-05 1.213E-04 1.519E-04 1.906E-04
 2.280E-04 2.671E-04 3.077E-04 7.805E-04 1.186E-03 1.451E-03 1.664E-03
 1.837E-03 1.979E-03 2.096E-03 2.194E-03 2.277E-03 2.630E-03 2.645E-03
 2.565E-03 2.454E-03 2.337E-03 2.222E-03 2.112E-03 2.010E-03 1.914E-03
 1.693E-03 1.509E-03 1.365E-03 1.249E-03 1.134E-03 8.516E-04 6.863E-04
 5.805E-04 5.064E-04 4.511E-04 4.081E-04 3.736E-04 3.452E-04 1.736E-04
 1.032E-04 7.617E-05 6.139E-05

* ANG-DEP. SPUTTERING COEFFT FOR TF D+

*
 5.083E-05 1.598E-04 2.849E-04 4.475E-04 6.351E-04 8.454E-04 1.077E-03
 1.328E-03 1.704E-03 1.914E-03 3.733E-03 5.106E-03 6.159E-03 6.983E-03
 7.639E-03 8.168E-03 8.598E-03 8.949E-03 9.238E-03 1.034E-02 1.022E-02
 9.789E-03 9.282E-03 8.774E-03 8.291E-03 7.841E-03 7.427E-03 7.046E-03
 6.227E-03 5.547E-03 5.018E-03 4.504E-03 4.245E-03 3.132E-03 2.524E-03
 2.135E-03 1.862E-03 1.658E-03 1.501E-03 1.374E-03 1.270E-03 6.386E-04
 3.797E-04 2.891E-04 2.258E-04

* ANG-DEP. SPUTTERING COEFFT FOR FI 4HE+

*
 1.581E-03 4.537E-03 8.405E-03 1.302E-02 1.828E-02 2.412E-02 2.942E-02
 3.490E-02 4.036E-02 4.578E-02 9.530E-02 1.355E-01 1.680E-01 1.946E-01
 2.167E-01 2.352E-01 2.508E-01 2.641E-01 2.754E-01 3.301E-01 3.397E-01
 3.350E-01 3.249E-01 3.128E-01 3.003E-01 2.879E-01 2.760E-01 2.646E-01
 2.331E-01 2.076E-01 1.878E-01 1.719E-01 1.589E-01 1.172E-01 9.447E-02
 7.991E-02 6.970E-02 6.299E-02 5.617E-02 5.142E-02 4.752E-02 2.390E-02
 1.421E-02 1.048E-02 8.450E-03

* ANG-DEP. SPUTTERING COEFFT FOR CO H+

*

3.228E-05	8.188E-05	1.411E-04	2.077E-04	2.803E-04	3.580E-04	4.404E-04
5.269E-04	6.172E-04	7.110E-04	1.804E-03	2.740E-03	3.354E-03	3.846E-03
4.245E-03	4.573E-03	4.845E-03	5.071E-03	5.261E-03	6.077E-03	6.113E-03
5.927E-03	5.672E-03	5.401E-03	5.135E-03	4.882E-03	4.645E-03	4.424E-03
3.913E-03	3.485E-03	3.153E-03	2.887E-03	2.667E-03	1.968E-03	1.586E-03
1.142E-03	1.170E-03	1.042E-03	8.431E-04	8.633E-04	7.977E-04	4.012E-04
2.386E-04	1.760E-04	1.419E-04				

* ANG-DEP. SPUTTERING COEFFT FOR CO D+

*

1.166E-04	3.459E-04	6.534E-04	1.026E-03	1.456E-03	1.939E-03	2.469E-03
3.045E-03	3.908E-03	4.389E-03	8.569E-03	1.171E-02	1.412E-02	1.602E-02
1.752E-02	1.873E-02	1.972E-02	2.052E-02	2.118E-02	2.371E-02	2.343E-02
2.245E-02	2.129E-02	2.012E-02	1.901E-02	1.798E-02	1.703E-02	1.616E-02
1.428E-02	1.272E-02	1.151E-02	1.054E-02	9.735E-03	7.182E-03	5.789E-03
4.897E-03	4.271E-03	3.804E-03	3.442E-03	3.151E-03	2.911E-03	1.464E-03
8.707E-04	6.424E-04	5.177E-04				

* ANG-DEP. SPUTTERING COEFFT FOR CO 4HE+

*

8.789E-03	2.522E-02	4.674E-02	7.239E-02	1.016E-01	1.341E-01	1.636E-01
1.940E-01	2.244E-01	2.545E-01	5.299E-01	7.533E-01	9.341E-01	1.082E+00
1.205E+00	1.308E+00	1.395E+00	1.468E+00	1.531E+00	1.835E+00	1.889E+00
1.863E+00	1.806E+00	1.739E+00	1.670E+00	1.601E+00	1.534E+00	1.472E+00
1.296E+00	1.154E+00	1.044E+00	9.561E-01	8.834E-01	6.518E-01	5.253E-01
4.443E-01	3.875E-01	3.452E-01	3.123E-01	2.859E-01	2.642E-01	1.329E-01
7.902E-02	5.830E-02	4.698E-02				

* ANG-DEP. SPUTTERING COEFFT FOR NI H+

*

2.674E-04	6.783E-04	1.169E-03	1.721E-03	2.322E-03	2.866E-03	3.649E-03
4.365E-03	5.113E-03	5.891E-03	1.484E-02	2.270E-02	2.779E-02	3.186E-02
3.517E-02	3.789E-02	4.014E-02	4.202E-02	4.359E-02	5.035E-02	5.065E-02
4.811E-02	4.689E-02	4.475E-02	4.254E-02	4.044E-02	3.848E-02	3.665E-02
3.242E-02	2.888E-02	2.612E-02	2.392E-02	2.210E-02	1.630E-02	1.314E-02
1.112E-02	9.695E-03	8.636E-03	7.813E-03	7.153E-03	6.609E-03	3.324E-03
1.977E-03	1.458E-03	1.175E-03				

* ANG-DEP. SPUTTERING COEFFT FOR NI D+

*

4.153E-04	1.232E-03	2.328E-03	3.656E-03	5.183E-03	6.907E-03	8.787E-03
1.085E-02	1.392E-02	1.564E-02	3.053E-02	4.171E-02	5.032E-02	5.705E-02
6.241E-02	6.673E-02	7.024E-02	7.311E-02	7.547E-02	8.446E-02	8.348E-02
7.997E-02	7.533E-02	7.165E-02	6.773E-02	6.406E-02	6.068E-02	5.756E-02
5.087E-02	4.532E-02	4.100E-02	3.753E-02	3.468E-02	2.559E-02	2.062E-02
1.744E-02	1.521E-02	1.355E-02	1.226E-02	1.123E-02	1.037E-02	5.217E-03
3.102E-03	2.289E-03	1.844E-03				

* ANG-DEP. SPUTTERING COEFFT FOR NI 1HE+

*

1.476E-03	4.236E-03	7.848E-03	1.216E-02	1.707E-02	2.252E-02	2.747E-02
3.258E-02	3.768E-02	4.274E-02	3.898E-02	1.265E-01	1.569E-01	1.517E-01
2.023E-01	2.196E-01	2.342E-01	2.466E-01	2.572E-01	3.082E-01	3.172E-01
3.128E-01	3.033E-01	2.921E-01	2.804E-01	2.688E-01	2.577E-01	2.471E-01
2.176E-01	1.939E-01	1.754E-01	1.605E-01	1.483E-01	1.095E-01	8.821E-02
7.462E-02	6.598E-02	5.797E-02	5.245E-02	4.801E-02	4.437E-02	2.232E-02
1.327E-02	9.780E-03	7.890E-03				

* ANG-DEP. SPUTTERING COEFFT FOR CU H+

*

1.928E-03	4.988E-03	8.725E-03	1.295E-02	1.760E-02	2.261E-02	2.795E-02
3.358E-02	3.947E-02	4.562E-02	9.261E-02	1.162E-01	1.322E-01	1.433E-01
1.512E-01	1.569E-01	1.609E-01	1.638E-01	1.658E-01	1.637E-01	1.510E-01
1.380E-01	1.263E-01	1.160E-01	1.071E-01	9.924E-02	9.237E-02	8.629E-02
7.709E-02	6.867E-02	6.213E-02	5.637E-02	5.235E-02	3.877E-02	3.125E-02
2.643E-02	2.395E-02	2.054E-02	1.358E-02	1.701E-02	1.572E-02	7.905E-03
4.700E-03	3.468E-03	2.795E-03				

* ANG-DEP. SPUTTERING COEFFT FOR CU 1HE+

*

1.680E-03	4.683E-03	8.530E-03	1.305E-02	1.816E-02	2.378E-02	2.818E-02
3.384E-02	3.958E-02	4.536E-02	1.015E-01	1.512E-01	1.942E-01	2.313E-01
2.637E-01	2.921E-01	3.171E-01	3.394E-01	3.592E-01	4.763E-01	5.223E-01
5.396E-01	5.432E-01	5.396E-01	5.320E-01	5.222E-01	5.112E-01	4.996E-01
4.327E-01	3.855E-01	3.437E-01	3.193E-01	2.950E-01	2.177E-01	1.754E-01
1.484E-01	1.294E-01	1.153E-01	1.043E-01	9.548E-02	8.823E-02	4.438E-02
2.639E-02	1.947E-02	1.569E-02				

* ANG-DEP. SPUTTERING COEFFT FOR ZN H+

*

6.934E-05	1.759E-04	3.032E-04	4.462E-04	6.021E-04	7.692E-04	9.161E-04
1.132E-03	1.326E-03	1.527E-03	3.875E-03	5.886E-03	7.205E-03	8.262E-03
9.120E-03	9.825E-03	1.041E-02	1.089E-02	1.130E-02	1.305E-02	1.313E-02
1.273E-02	1.219E-02	1.169E-02	1.193E-02	1.049E-02	9.978E-03	9.504E-03
8.405E-03	7.488E-03	6.774E-03	6.201E-03	5.730E-03	4.228E-03	3.407E-03
2.882E-03	2.514E-03	2.239E-03	2.026E-03	1.855E-03	1.714E-03	8.620E-04
5.125E-04	3.781E-04	3.048E-04				

* ANG-DEP. SPUTTERING COEFFT FOR ZN D+

*

2.969E-04	8.810E-04	1.664E-03	2.614E-03	3.710E-03	4.938E-03	6.290E-03
7.756E-03	9.954E-03	1.118E-02	2.180E-02	2.982E-02	3.598E-02	4.079E-02
4.463E-02	4.771E-02	5.022E-02	5.128E-02	5.396E-02	6.039E-02	5.969E-02
5.718E-02	5.422E-02	5.125E-02	4.843E-02	4.580E-02	4.338E-02	4.116E-02
3.637E-02	3.249E-02	2.931E-02	2.684E-02	2.489E-02	1.830E-02	1.474E-02
1.247E-02	1.088E-02	9.691E-03	8.767E-03	8.026E-03	7.416E-03	3.730E-03
2.218E-03	1.636E-03	1.319E-03				

* ANG-DEP. SPUTTERING COEFFT FOR ZN 4HE+

*

7.707E-03	2.212E-02	4.098E-02	6.348E-02	8.913E-02	1.176E-01	1.435E-01
1.702E-01	1.968E-01	2.232E-01	4.647E-01	6.606E-01	8.192E-01	9.490E-01
1.057E+00	1.147E+00	1.223E+00	1.288E+00	1.343E+00	1.609E+00	1.656E+00
1.633E+00	1.584E+00	1.525E+00	1.464E+00	1.404E+00	1.346E+00	1.290E+00
1.136E+00	1.012E+00	9.158E-01	8.384E-01	7.747E-01	5.715E-01	4.606E-01
3.896E-01	3.398E-01	3.027E-01	2.739E-01	2.507E-01	2.317E-01	1.165E-01
6.929E-02	5.112E-02	4.129E-02				

* ANG-DEP. SPUTTERING COEFFT FOR ZP H+

*

8.482E-07	2.222E-06	3.902E-06	5.818E-06	7.932E-06	1.022E-05	1.266E-05
1.524E-05	1.795E-05	2.077E-05	3.441E-05	9.555E-05	1.425E-04	1.850E-04
2.174E-04	2.465E-04	2.728E-04	2.965E-04	3.180E-04	4.498E-04	5.033E-04
5.235E-04	5.273E-04	5.226E-04	5.132E-04	5.013E-04	4.880E-04	4.742E-04
4.165E-04	3.710E-04	3.357E-04	3.073E-04	2.839E-04	2.095E-04	1.688E-04
1.428E-04	1.246E-04	1.110E-04	1.004E-04	9.190E-05	8.492E-05	4.271E-05
2.540E-05	1.874E-05	1.510E-05				

* ANG-DEP. SPUTTERING COEFFT FOR ZF D+

*

2.847E-06	8.400E-06	1.582E-05	2.478E-05	3.511E-05	4.667E-05	5.937E-05
7.313E-05	8.789E-05	1.036E-04	3.057E-04	5.108E-04	6.836E-04	8.384E-04
9.765E-04	1.100E-03	1.210E-03	1.309E-03	1.398E-03	1.937E-03	2.151E-03
2.229E-03	2.242E-03	2.221E-03	2.181E-03	2.131E-03	2.076E-03	2.019E-03
1.773E-03	1.579E-03	1.429E-03	1.308E-03	1.208E-03	8.916E-04	7.185E-04
6.078E-04	5.301E-04	4.722E-04	4.272E-04	3.911E-04	3.614E-04	1.818E-04
1.081E-04	7.974E-05	6.427E-05				

* ANG-DEP. SPUTTERING COEFFT FOR ZR 4HE+

*

6.985E-05	2.397E-04	4.932E-04	8.227E-04	1.224E-03	1.692E-03	2.226E-03
2.823E-03	3.246E-03	3.845E-03	1.071E-02	1.813E-02	2.550E-02	3.261E-02
3.939E-02	4.583E-02	5.192E-02	5.768E-02	6.313E-02	1.045E-01	1.305E-01
1.479E-01	1.600E-01	1.685E-01	1.746E-01	1.790E-01	1.820E-01	1.841E-01
1.586E-01	1.413E-01	1.278E-01	1.170E-01	1.081E-01	7.976E-02	6.428E-02
5.438E-02	4.743E-02	4.225E-02	3.822E-02	3.499E-02	3.233E-02	1.626E-02
9.670E-03	7.134E-03	5.750E-03				

* ANG-DEP. SPUTTERING COEFFT FOR NB H+

*

2.047E-05	5.361E-05	9.415E-05	1.404E-04	1.914E-04	2.466E-04	3.055E-04
3.677E-04	4.331E-04	5.013E-04	1.313E-03	2.306E-03	3.438E-03	4.463E-03
5.245E-03	5.949E-03	6.584E-03	7.156E-03	7.670E-03	1.085E-02	1.215E-02
1.263E-02	1.273E-02	1.261E-02	1.238E-02	1.210E-02	1.178E-02	1.144E-02
1.005E-02	8.953E-03	8.100E-03	7.415E-03	6.852E-03	5.055E-03	4.074E-03
3.446E-03	3.006E-03	2.678E-03	2.422E-03	2.219E-03	2.049E-03	1.031E-03
6.128E-04	4.521E-04	3.644E-04				

* ANG-DEP. SPUTTERING COEFFT FOR NB D+

*

2.419E-05	7.137E-05	1.344E-04	2.106E-04	2.983E-04	3.965E-04	5.044E-04
6.213E-04	7.167E-04	8.802E-04	2.597E-03	4.340E-03	5.808E-03	7.123E-03
8.297E-03	9.344E-03	1.028E-02	1.112E-02	1.188E-02	1.646E-02	1.827E-02
1.894E-02	1.905E-02	1.987E-02	1.853E-02	1.811E-02	1.764E-02	1.715E-02
1.506E-02	1.342E-02	1.214E-02	1.111E-02	1.027E-02	7.575E-03	6.105E-03
5.164E-03	4.504E-03	4.012E-03	3.630E-03	3.323E-03	3.071E-03	1.544E-03
9.183E-04	6.775E-04	5.460E-04				

* ANG-DEP. SPUTTERING COEFFT FOR NB 4HE+

*

8.007E-05	2.748E-04	5.653E-04	9.431E-04	1.403E-03	1.940E-03	2.552E-03
3.236E-03	3.721E-03	4.408E-03	1.228E-02	2.078E-02	2.923E-02	3.738E-02
4.516E-02	5.253E-02	5.951E-02	6.612E-02	7.237E-02	1.108E-01	1.496E-01
1.695E-01	1.874E-01	1.932E-01	2.002E-01	2.051E-01	2.086E-01	2.110E-01
1.818E-01	1.610E-01	1.465E-01	1.341E-01	1.239E-01	9.143E-02	7.369E-02
6.233E-02	5.436E-02	4.843E-02	4.381E-02	4.011E-02	3.706E-02	1.864E-02
1.108E-02	8.178E-03	6.591E-03				

* ANG-DEP. SPUTTERING COEFFT FOR MO H+

*

1.263E-05	3.349E-05	5.925E-05	8.881E-05	1.216E-04	1.571E-04	1.952E-04
2.355E-04	2.780E-04	3.224E-04	3.549E-04	1.513E-03	2.267E-03	2.958E-03
3.519E-03	4.033E-03	4.503E-03	4.933E-03	5.327E-03	7.893E-03	9.075E-03
9.623E-03	9.840E-03	9.871E-03	9.794E-03	9.652E-03	9.472E-03	9.269E-03
8.112E-03	7.226E-03	6.537E-03	5.935E-03	5.530E-03	4.080E-03	3.238E-03
2.781E-03	2.426E-03	2.161E-03	1.955E-03	1.790E-03	1.654E-03	8.319E-04
4.946E-04	3.649E-04	2.941E-04				

* ANG-DEP. SPUTTERING COEFFT FOR MO D+

*

4.968E-05	1.366E-04	2.468E-04	3.755E-04	5.200E-04	6.784E-04	8.495E-04
1.032E-03	1.226E-03	1.429E-03	3.930E-03	6.361E-03	8.146E-03	9.660E-03
1.095E-02	1.206E-02	1.302E-02	1.384E-02	1.457E-02	1.835E-02	1.933E-02
1.932E-02	1.891E-02	1.832E-02	1.767E-02	1.700E-02	1.633E-02	1.570E-02
1.382E-02	1.231E-02	1.114E-02	1.020E-02	9.421E-03	6.951E-03	5.602E-03
4.739E-03	4.133E-03	3.682E-03	3.331E-03	3.049E-03	2.818E-03	1.417E-03
8.427E-04	6.217E-04	5.010E-04				

* ANG-DEP. SPUTTERING COEFFT FOR MO 4HE+

*

2.215E-04	6.924E-04	1.348E-03	2.164E-03	3.123E-03	4.214E-03	5.430E-03
6.763E-03	8.582E-03	9.863E-03	2.225E-02	3.390E-02	4.207E-02	4.973E-02
5.625E-02	6.183E-02	6.664E-02	7.030E-02	7.442E-02	9.332E-02	9.815E-02
9.805E-02	9.595E-02	9.299E-02	8.970E-02	8.633E-02	8.301E-02	7.980E-02
7.042E-02	6.273E-02	5.675E-02	5.195E-02	4.800E-02	3.542E-02	2.954E-02
2.415E-02	2.106E-02	1.876E-02	1.697E-02	1.554E-02	1.436E-02	7.221E-03
4.294E-03	3.168E-03	2.553E-03				

* ANG-DEP. SPUTTERING COEFFT FOR PH H+

*

1.168E-06	3.097E-06	5.480E-06	8.214E-06	1.124E-05	1.453E-05	1.805E-05
2.178E-05	2.571E-05	2.981E-05	7.906E-05	1.309E-04	2.097E-04	2.735E-04
3.254E-04	3.729E-04	4.164E-04	4.562E-04	4.926E-04	7.299E-04	8.393E-04
8.899E-04	9.100E-04	9.129E-04	9.058E-04	8.927E-04	8.760E-04	8.572E-04
7.502E-04	6.683E-04	6.046E-04	5.535E-04	5.114E-04	3.773E-04	3.041E-04
2.572E-04	2.244E-04	1.989E-04	1.808E-04	1.655E-04	1.530E-04	7.693E-05
4.574E-05	3.375E-05	2.720E-05				

* ANG-DEP. SPUTTERING COEFFT FOR PH D+

*

1.267E-05	3.433E-05	6.293E-05	9.574E-05	1.326E-04	1.730E-04	2.166E-04
2.632E-04	3.126E-04	3.645E-04	1.002E-03	1.622E-03	2.077E-03	2.463E-03
2.793E-03	3.075E-03	3.319E-03	3.530E-03	3.715E-03	4.680E-03	4.929E-03
4.927E-03	4.831E-03	4.572E-03	4.503E-03	4.334E-03	4.165E-03	4.002E-03
3.524E-03	3.139E-03	2.840E-03	2.600E-03	2.402E-03	1.772E-03	1.428E-03
1.208E-03	1.054E-03	9.388E-04	8.494E-04	7.776E-04	7.185E-04	3.614E-04
2.149E-04	1.585E-04	1.278E-04				

* ANG-DEP. SPUTTERING COEFFT FOR PH 4HE+

*

4.125E-04	1.289E-03	2.511E-03	4.029E-03	5.815E-03	7.847E-03	1.011E-02
1.259E-02	1.589E-02	1.877E-02	4.143E-02	6.144E-02	7.833E-02	9.260E-02
1.047E-01	1.151E-01	1.241E-01	1.318E-01	1.386E-01	1.738E-01	1.827E-01
1.826E-01	1.787E-01	1.731E-01	1.670E-01	1.607E-01	1.546E-01	1.486E-01
1.311E-01	1.168E-01	1.057E-01	9.673E-02	8.938E-02	6.585E-02	5.315E-02
4.496E-02	3.921E-02	3.493E-02	3.160E-02	2.893E-02	2.673E-02	1.345E-02
7.995E-03	5.898E-03	4.754E-03				

* ANG-DEP. SPUTTERING COEFFT FOR AG H+

*

3.943E-06	1.046E-05	1.550E-05	2.773E-05	3.796E-05	4.905E-05	6.094E-05
7.353E-05	8.678E-05	1.007E-04	2.669E-04	4.722E-04	7.078E-04	9.235E-04
1.099E-03	1.259E-03	1.406E-03	1.540E-03	1.663E-03	2.464E-03	2.833E-03
3.004E-03	3.072E-03	3.082E-03	3.058E-03	3.013E-03	2.957E-03	2.894E-03
2.532E-03	2.256E-03	2.041E-03	1.868E-03	1.726E-03	1.274E-03	1.027E-03
8.684E-04	7.574E-04	6.747E-04	6.104E-04	5.588E-04	5.163E-04	2.597E-04
1.544E-04	1.139E-04	9.182E-05				

* ANG-DEP. SPUTTERING COEFFT FOR AG D+

*

4.312E-05	1.185E-04	2.142E-04	3.259E-04	4.513E-04	5.888E-04	7.373E-04
8.959E-04	1.064E-03	1.241E-03	3.411E-03	5.521E-03	7.070E-03	8.384E-03
9.505E-03	1.047E-02	1.130E-02	1.202E-02	1.264E-02	1.593E-02	1.678E-02
1.677E-02	1.641E-02	1.590E-02	1.533E-02	1.475E-02	1.418E-02	1.362E-02
1.199E-02	1.068E-02	9.666E-03	8.849E-03	8.177E-03	6.033E-03	4.862E-03
4.113E-03	3.537E-03	3.195E-03	2.891E-03	2.646E-03	2.445E-03	1.230E-03
7.313E-04	5.396E-04	4.349E-04				

* ANG-DEP. SPUTTERING COEFFT FOR AG 4HE+

*

1.410E-03	4.407E-03	8.583E-03	1.377E-02	1.988E-02	2.682E-02	3.456E-02
4.305E-02	5.463E-02	6.278E-02	1.416E-01	2.100E-01	2.678E-01	3.165E-01
3.580E-01	3.936E-01	4.242E-01	4.507E-01	4.737E-01	5.940E-01	6.247E-01
6.241E-01	6.107E-01	5.919E-01	5.709E-01	5.495E-01	5.284E-01	5.080E-01
4.482E-01	3.993E-01	3.612E-01	3.307E-01	3.055E-01	2.254E-01	1.817E-01
1.537E-01	1.340E-01	1.194E-01	1.030E-01	9.889E-02	9.138E-02	4.596E-02
2.733E-02	2.016E-02	1.625E-02				

* ANG-DEP. SPUTTERING COEFFT FOR TA H+

*

9.920E-08	2.165E-07	3.418E-07	4.725E-07	6.075E-07	7.460E-07	8.874E-07
1.031E-06	1.178E-06	1.326E-06	2.394E-06	4.568E-06	6.316E-06	8.120E-06
9.971E-06	1.186E-05	1.378E-05	1.551E-05	1.674E-05	2.441E-05	2.757E-05
2.874E-05	2.894E-05	2.863E-05	2.804E-05	2.731E-05	2.650E-05	2.566E-05
2.259E-05	2.012E-05	1.820E-05	1.666E-05	1.540E-05	1.136E-05	9.155E-06
7.744E-06	6.755E-06	6.017E-06	5.144E-06	4.983E-06	4.605E-06	2.316E-06
1.377E-06	1.016E-06	8.189E-07				

* ANG-DEP. SPUTTERING COEFFT FOR TA D+

*

5.125E-07	1.206E-06	1.990E-06	2.840E-06	3.741E-06	4.685E-06	5.668E-06
6.684E-06	7.730E-06	8.805E-06	2.072E-05	3.419E-05	4.878E-05	6.426E-05
7.913E-05	8.998E-05	9.979E-05	1.087E-04	1.167E-04	1.672E-04	1.885E-04
1.971E-04	1.995E-04	1.984E-04	1.955E-04	1.915E-04	1.869E-04	1.820E-04
1.591E-04	1.417E-04	1.282E-04	1.173E-04	1.084E-04	8.000E-05	6.448E-05
5.454E-05	4.757E-05	4.238E-05	3.834E-05	3.510E-05	3.243E-05	1.631E-05
9.699E-06	7.156E-06	5.767E-06				

* ANG-DEP. SPUTTERING COEFFT FOR TA 4HE+

*

6.467E-05	1.480E-04	2.401E-04	3.385E-04	4.419E-04	5.493E-04	6.603E-04
7.745E-04	8.914E-04	1.011E-03	2.313E-03	3.753E-03	5.292E-03	6.907E-03
8.587E-03	9.930E-03	1.114E-02	1.227E-02	1.331E-02	2.043E-02	2.411E-02
2.609E-02	2.714E-02	2.764E-02	2.778E-02	2.771E-02	2.745E-02	2.716E-02
2.369E-02	2.111E-02	1.905E-02	1.748E-02	1.615E-02	1.192E-02	9.604E-03
8.124E-03	7.036E-03	6.312E-03	5.711E-03	5.228E-03	4.831E-03	2.430E-03
1.445E-03	1.066E-03	8.590E-04				

* ANG-DEP. SPUTTERING COEFFT FOR W H+

*

5.579E-06	1.218E-05	1.922E-05	2.658E-05	3.417E-05	4.196E-05	4.991E-05
5.801E-05	6.623E-05	7.457E-05	1.628E-04	2.569E-04	3.552E-04	4.567E-04
5.608E-04	6.671E-04	7.753E-04	8.725E-04	9.415E-04	1.373E-03	1.550E-03
1.616E-03	1.628E-03	1.610E-03	1.577E-03	1.536E-03	1.490E-03	1.443E-03
1.270E-03	1.132E-03	1.024E-03	9.372E-04	8.660E-04	6.389E-04	5.149E-04
4.356E-04	3.799E-04	3.384E-04	3.062E-04	2.803E-04	2.590E-04	1.303E-04
7.746E-05	5.715E-05	4.606E-05				

* ANG-DEP. SPUTTERING COEFFT FOR W D+

*

1.005E-05	2.365E-05	3.901E-05	5.566E-05	7.332E-05	9.183E-05	1.111E-04
1.310E-04	1.515E-04	1.726E-04	4.062E-04	6.702E-04	9.561E-04	1.260E-03
1.551E-03	1.764E-03	1.956E-03	2.130E-03	2.288E-03	3.277E-03	3.694E-03
3.864E-03	3.910E-03	3.889E-03	3.832E-03	3.753E-03	3.663E-03	3.568E-03
3.118E-03	2.777E-03	2.512E-03	2.300E-03	2.125E-03	1.568E-03	1.264E-03
1.069E-03	9.324E-04	8.706E-04	7.514E-04	6.879E-04	6.356E-04	3.197E-04
1.901E-04	1.402E-04	1.130E-04				

* ANG-DEP. SPUTTERING COEFFT FOR W 4HE+

*

1.702E-04	3.894E-04	6.315E-04	8.908E-04	1.163E-03	1.446E-03	1.738E-03
2.038E-03	2.346E-03	2.660E-03	6.087E-03	9.877E-03	1.393E-02	1.818E-02
2.260E-02	2.613E-02	2.932E-02	3.228E-02	3.501E-02	5.377E-02	6.345E-02
6.867E-02	7.143E-02	7.273E-02	7.312E-02	7.291E-02	7.232E-02	7.147E-02
6.235E-02	5.554E-02	5.025E-02	4.600E-02	4.251E-02	3.136E-02	2.527E-02
2.138E-02	1.865E-02	1.661E-02	1.503E-02	1.376E-02	1.271E-02	6.394E-03
3.802E-03	2.805E-03	2.261E-03				

* ANG-DEP. SPUTTERING COEFFT FOR AU H+

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4.342E-05	1.251E-04	2.322E-04	3.601E-04	5.062E-04	6.686E-04	8.460E-04
1.037E-03	1.241E-03	1.458E-03	4.156E-03	7.795E-03	1.209E-02	1.609E-02
1.953E-02	2.275E-02	2.576E-02	2.856E-02	3.118E-02	4.947E-02	5.906E-02
6.426E-02	6.700E-02	6.826E-02	6.960E-02	6.835E-02	6.772E-02	6.682E-02
5.847E-02	5.209E-02	4.713E-02	4.314E-02	3.986E-02	2.941E-02	2.370E-02
2.005E-02	1.749E-02	1.558E-02	1.409E-02	1.290E-02	1.192E-02	5.996E-03
3.565E-03	2.631E-03	2.120E-03				

* ANG-DEP. SPUTTERING COEFFT FOR AU D+

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3.163E-04	7.347E-04	1.203E-03	1.707E-03	2.239E-03	2.794E-03	3.371E-03
3.965E-03	4.575E-03	5.201E-03	1.208E-02	1.978E-02	2.807E-02	3.535E-02
4.174E-02	4.757E-02	5.288E-02	5.773E-02	6.216E-02	9.099E-02	1.044E-01
1.108E-01	1.136E-01	1.143E-01	1.137E-01	1.124E-01	1.106E-01	1.086E-01
9.477E-02	8.442E-02	7.637E-02	6.992E-02	6.461E-02	4.767E-02	3.841E-02
3.249E-02	2.834E-02	2.525E-02	2.284E-02	2.091E-02	1.932E-02	9.718E-03
5.778E-03	4.263E-03	3.436E-03				

* ANG-DEP. SPUTTERING COEFFT FOR AU 4HE+

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4.508E-04	1.458E-03	2.896E-03	4.713E-03	6.876E-03	9.363E-03	1.215E-02
1.524E-02	1.882E-02	2.186E-02	5.286E-02	8.167E-02	1.072E-01	1.297E-01
1.494E-01	1.669E-01	1.824E-01	1.962E-01	2.085E-01	2.811E-01	3.086E-01
3.179E-01	3.186E-01	3.148E-01	3.088E-01	3.015E-01	2.936E-01	2.855E-01
2.500E-01	2.227E-01	2.015E-01	1.845E-01	1.704E-01	1.258E-01	1.013E-01
8.573E-02	7.477E-02	6.661E-02	6.026E-02	5.517E-02	5.098E-02	2.564E-02
1.525E-02	1.125E-02	9.065E-03				