STOPPING POWERS OF METALLIC ELEMENTS FOR 6.5 MEV PROTONS

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Stopping powers of Be, Al, Ti, V, Fe, Co, Ni, Cu, Zn, Mo, Rh, Ag, Sn, Ta, Pt and Au have been measured for 6.75 MeV protons from the Kyoto University Cycrotron using a surface barrier silicon detector. The experimental procedures are similar to those described in the previous papers(1,2). What we call the absorber wheel technique(1,2) has been used to measure the pulse heights with and without the sample target simultaneously in one exposure. The pulse height spectrum has been calibrated by a very high precision pulse generator (ORTEC 448).
The thickness of the sample target has been chosen in such a way that the energy loss of protons in the target is nearly 500 keV. Therefore, the average energy of protons in the target is very close to 6.5 MeV. The results have been reduced to 6.5 MeV by assuming that the stopping power is proportional to $\ln v^2/v^2$ in a narrow velocity range.

In Table I, the present results are shown and compared with the Risø data of Andersen et al. The uncertainty of the present results has been estimated to be ±0.3%.

Table I

Comparison of the present data with the Risø data. The stopping power is given in keV/mg cm^2. Δ denotes the percentage difference.

Element	Be	Al	Ti	V	Fe	Co	Ni	Cu
Present data	53.34 ±0.16	46.83 ±0.14	40.72 ±0.12	39.58 ±0.12	39.02 ±0.12	37.86 ±0.11	38.79 ±0.12	36.71 ±0.11
Risø data	53.42 ±0.16	47.34 ±0.14	41.10 ±0.12	39.90 ±0.12	39.31 ±0.12	38.00 ±0.11	39.30 ±0.12	37.00 ±0.11
Δ(%)	-0.15 ±0.43	-1.09 ±0.43	-0.93 ±0.42	-0.81 ±0.43	-0.74 ±0.44	-0.37 ±0.42	-1.31 ±0.44	-0.79 ±0.44

Element	Zn	Mo	Rh	Ag	Sn	Ta	Pt	Au
Present data	36.31 ±0.11	32.31 ±0.10	31.43 ±0.09	30.86 ±0.09	29.60 ±0.09	24.64 ±0.07	23.66 ±0.07	23.52 ±0.07
Risø data	37.07 ±0.11			30.96 ±0.09		24.79 ±0.07	23.60 ±0.07	23.72 ±0.07
Δ(%)	-1.26 ±0.44			-0.32 ±0.42		-0.61 ±0.41	+0.25 ±0.42	-0.85 ±0.42

Risø data are systematically higher than the present results,on average the Riso data are higher than the present results by 0.7%.

We write the Bethe-Bloch Formula as follows

$$-\frac{dE}{dx} = \frac{4\pi e^4 Z_1^2}{m v_1^2} N_2 Z_2 \left\{ \ln \frac{2mv_1^2}{I} - \frac{C}{Z_2} + \Phi + L_1 Z_1 \right\}$$

Were Φ denotes the Bloch correction and $L_1 Z_1$ represents the Z_1^3-correction. We have adoped the shell correction of Bonderup(8) and Z_1^3-correction of Ashley, Ritchie and Brandt(9-11). To evaluate the Z_1^3-correction we took χ=1.358 and b=1.3. The results are shown in Table II and compared with the values given by Turner(12) and Ziegler(13).

Table II

Element	Present result	Turner	Ziegler	Element	Present result	Turner	Ziegler
Be	64.0±1.0	61.7	63	Zn	331.3±8.2	319	323
Al	167.7±2.8	163	162	Mo	413 ±12	422	393
Ti	232.3±4.9	224	228	Rh	445 ±14	440	436
V	241.8±5.2	250	237	Ag	464 ±15	466	470
Fe	282.5±6.5	277	284	Sn	471 ±15	486	512
Co	295.9±6.9	290	304	Ta	676 ±26	692	682
Ni	312.7±7.4	312	314	Pt	730 ±29	711	760
Cu	323.5±7.9	316	330	Au	746 ±30	760	742

The present results agree fairly well with the values given by Turner and Ziegler.

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