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Attenuation of low energy gamma rays in alloys

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With the increasing use of gamma active isotopes in industry, medicine and agriculture, it is becoming necessary to study the absorption of gamma radiation in various materials. While the absorption in elements is widely studied, very few attempts (*e.g.* Rama Rao *et al* (1961) seem to have been made to measure the attenuation of gamma rays in alloys and compounds. In the work by Rama Rao *et al* (1961) one of the present authors determined the total cross-sections for a few alloys and compounds at two gamma energies and compared the results with the predictions of an apporximate theory based on several assumptions. No further measurements, particularly, at lower photon energies, seem to have been reported so far. Furthermore, with the availability of more accurate theoretical cross-sections it now becomes possible to make a meaningful comparison between theory and experiment. Hence the present investigations are undertaken selecting two platinum-rhodium alloys having the composition, Alloy *A* : Pt 80% + Rh 20%; Alloy B : Pt 60% + Rh 40%, and gamma rays of energies 84, 100 and 280 keV provided by radioactive isotopes Tm^{170}, Gm^{153} and Hg^{203} respectively.

The isotopes of strength about 10 mC each, are obtained from the Bhabha Atomic Research Centre, Bombay, India. The total gamma ray cross-sections for the two alloys are determined following the same procedure as adopted earlier on a good geometry set up by Lakshminarayana *et al* (1961). The theoretical values of the cross-section for the two alloys at the three photon energies are computed making use of the theoretical sum rule and the total gamma ray cross-section in Pt and Rh taken from the recently compiled data of Plechaty (1968). The experimental and the compiled values are given in table 1.

It can be seen from table 1 that there is excellent agreement between the compiled and experimental values at 280 keV. The agreement is not so good at 100 keV and there is definite deviation at 84 keV beyond the ascribed errors. It may be also noted that the deviation is more for alloy *A* which contains larger proportion of Pt. These two observations indicate that the discrepancy might be due to an overestimation of photoelectric cross-section which forms a dominant part of the total cross-section for heavy elements and low energies.

TABLE 1. TOTAL GAMMA RAY CROSS SECTIONS IN ALLOYS BARNS PER ATOM

Energy keV	Alloy A Pt80%+Rh20%	Alloy B Pt60%+Rh40%
84 Experimental :	1580±80	1160±58
Values of Plechaty :	1785±18	1275±13
100 Experimental :	1070±54	773±36
Values of Plechaty :	1147±12	825±8
280 Experimental :	97.5±1.9	72.7±1.5
Values of Plechaty :	97.6±1.0	73.8±0.7

TABLE 2. EFFECTIVE ATOMIC NUMBERS FOR TOTAL GAMMA RAY INTERATION

Energy keV	Alloy A	Alloy B
84	69.5±1.0	63.±1.0
100	70.0±1.0	63.±1.0
280	69.±1.0	62.5±1.0

The effective atomic numbers for the two alloys at each energy are deduced from plots between the total atomic cross-section versus atomic number for elements at each energy, employing the earlier results of Ramana Rao *et al* (1969), Parthasaradhi *et al* (1969) in press and Rama Rao (Ph.D. Thesis, 1964). These values are given in table 2. According to Hine (1952) the effective atomic number for total gamma ray interaction in alloys can not be represented by a single number and for each partial process the number has to be determined separately. However, from table 2 it may be noted that the number remains constant at these three energies. This may be due to the fact that the number for total interaction is mostly dominated by the number for photoelectric process in the present region of energy since most of the cross-section contribution to the total is due to that of photoelectric effect. Even though a little variation exists, it lies within the error limits of the present values.

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