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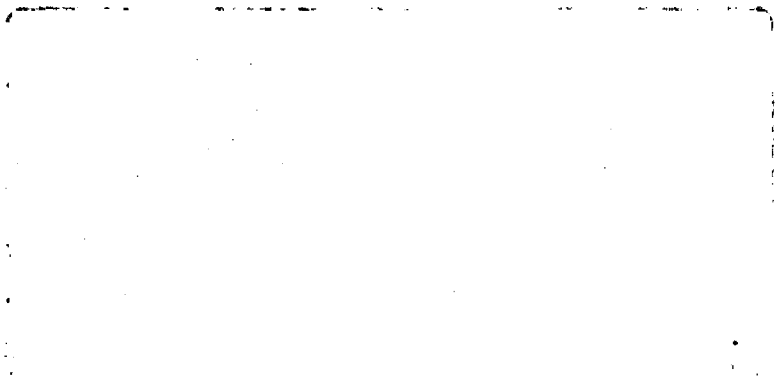

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PREPARATION OF LONG-LIVED HOLMIUM-163

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PREPARATION OF LONG-LIVED HOLMIUM-163*

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Previous investigations of holmium-163 have only indicated the presence of an activity with a 0.8-sec decay period.[1,2] This activity may be presumed to be an isomer of a long-lived ground state for which half-life limits have been set.[3] Holmium-163 is anticipated to have a ground-state nuclear spin of 7/2 and odd (negative) parity as is suggested from nuclear spectroscopic investigations of the other holmium isotopes. Similar considerations reinforce the measured value of 5/2 for the ground-state nuclear spin of stable dysprosium-163 and indicate odd (negative) parity.[4] However, an examination of the vicinal stable isotopes of odd atomic number indicates that holmium-163 is almost beta-stable. Thus an allowed low-energy electron-capture decay of holmium-163 to dysprosium-163, probably accounts for the absence of natural holmium-163, which may be anticipated to have a long lifetime.

A sample of holmium-163 has been prepared by pile neutron irradiation of a sample of erbium oxide electromagnetically enriched one-hundredfold in the mass-162 isotope. Five milligrams of the erbium-162 sample contained in a quartz ampoule received an exposure of 2×10^{21} neutrons /cm^2 in the Materials Testing Reactor over a 3-month interval. Four months after the end of irradiation

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†Proctor and Gamble Faculty Fellow, Princeton University, Princeton, N.J.

mass analysis of the sample (before chemical separation) in a 30-cm-radius single-direction focusing mass spectrometer showed the presence of isotopes of mass number 163 and 165 which were not observed in the sample prior to irradiation. On the basis of the mass analysis, approximately 5 to 10% of each of the erbium-162 and erbium-164 isotopes has undergone neutron capture.

The sample was next chemically fractionated by cation-exchange chromatography to yield pure fractions of the various rare earth elements. The thulium, dysprosium, and terbium fractions were identified by scintillation gamma spectroscopy which revealed the presence of thulium-170, dysprosium-159, and terbium-160. The erbium fraction was recognized by optical-emission spectroscopy, while weak gamma radiation extending to approximately 1 Mev (presumably due to holmium-166) characterized the holmium fraction. Mass-spectrometric investigation of each fraction revealed the existence of isotopes at masses 163 and 165 in the holmium fraction (see Fig. 1); however no isotopes of these mass numbers were observed in either the erbium or dysprosium fractions in measurable yield. The erbium fraction did show considerable depletion of the erbium-167, which indicates the high capture cross section of this isotope.

From these data and the strength of the K radiation in the holmium fraction (principally attributable to holmium-166), we conclude that the K-capture half life of holmium-163 is greater than 1,000 yr. The holmium fraction will be examined further for evidence of electron capture, and erbium-isotope capture cross sections will be determined.

We should like to express our appreciation to the staff of the Materials Testing Reactor for carrying out the neutron irradiation.

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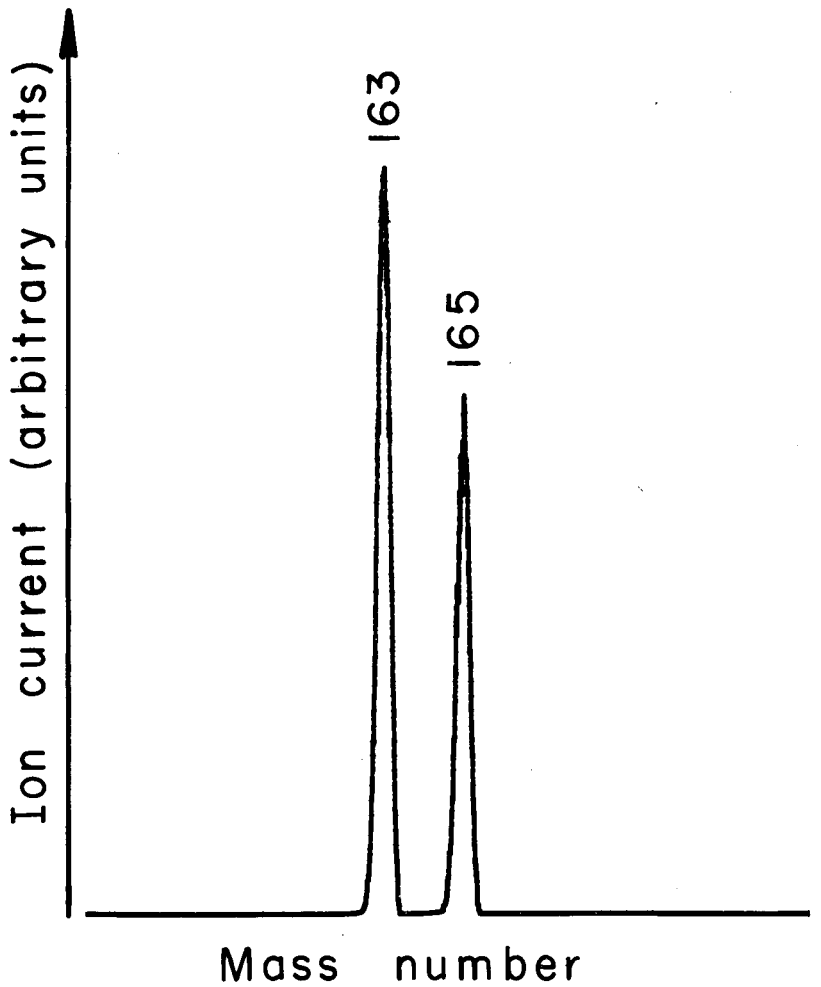

Fig. 1. Mass spectrum of the purified holmium fraction showing the long-lived 163 and stable 165 holmium isotopes.