salts leads to the hexagonal hexahydrates, the ferroelectric behavior of which has been reported by Holden, Matthias, Merz, and Remeika.[3]

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Resistivity Increase in Water-Quenched Gold*

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Upon quenching into water from a high temperature (650–950°C) an increase in the resistivity of gold wires (99.999% pure, 16 and 30 mil diameter) has been observed. The increase is describable by an equation of the form $\Delta\rho = Ae^{-E_F/kT}$, where $\Delta\rho$ is the increase in resistivity, A is a constant, T is the absolute temperature from which the quench is made, and E_F is the energy of formation of the defects responsible for the resistivity increase. It is found that $E_F = (1.02\pm0.06)$ ev, and that for a quench from 800°C, $\Delta\rho = 1.2\times10^{-8}$ ohm-cm. Sample results are shown in Fig. 1. All measurements were made at liquid-nitrogen temperature. The total time required to quench to room temperature ranged from 20 to 50 milliseconds.

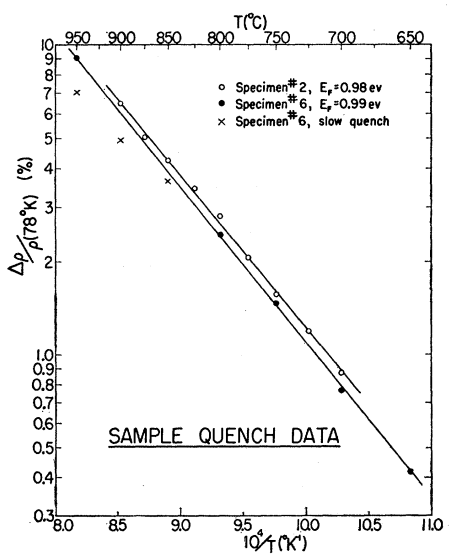

Fig. 1. The dependence of the quenched-in resistivity on the quenching temperature. Note that slow quenches indicated by × give points falling below the expected exponential dependence, particularly at high temperatures.

If too slow a quench is used, deviations occur at the higher temperatures as shown by the points marked × for specimen number 6. Experiments using other liquid quenching media indicate that the results are independent of the liquid used.

At least 90% of the quenched-in resistance anneals out at room temperature, and isothermal annealing measurements yield an energy of motion of (0.66 ± 0.06) ev for the defects. This agrees with the previous work of Kauffman and Koehler,[1] who reported a value of $E_M = (0.68\pm0.03)$ ev. The initial part of the annealing curve deviates somewhat from that for a second-order process. For a quench from 800°C with no deformation present, approximately 70 hours are required for half of the quenched-in resistance to anneal out at 30°C. Quenches involving small amounts of deformation from below 950°C give the same value of $\Delta\rho/\rho$ as those in which no deformation occurred. The rate of annealing and the energy of motion were, however, strongly affected by deformation. The rate increased on deformation by at least an order of magnitude and the apparent energy of motion was decreased in some cases to less than half the value found when deformation is not present. The annealing behavior was used as a sensitive test for any deformation which might occur during the quench.

Assuming that the defects involved are vacancies, the activation energy for self-diffusion in gold is found to be $Q = E_F + E_M = (1.68\pm0.12)$ ev, which compares favorably with $Q = 1.70$ ev found by Okkerse[2] using tracer techniques.

Further measurements on gold, and also on silver and copper are in progress.

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Mass of B^{13} from the Nuclear Reaction $Li^7(Li^7,p)B^{13}$

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It has been predicted that the nuclear species $_5B^{13}$ will be found to be stable with respect to disintegration into heavy charged particles,[1] and Snell[2] has suggested that it may, by analogy with N^{17}, be a delayed-neutron emitter. The delayed neutrons have been searched for in fission and spallation fragments with negative results.[3,4] We have found that B^{13} may be prepared by means of the reaction $Li^7(Li^7,p)B^{13}$.

A 2-Mev Van de Graaff accelerator has been converted to the acceleration of Li ions, obtained by

evaporation from a hot filament coated with lithium salts. A 90° electrostatic analyzer selects a beam homogeneous in energy within 1.0% and the lithium isotopes are then separated by a 22.5° magnetic deflection. The experiments were conducted at a beam energy of 1.61±0.02 Mev, and beam currents in the range 0.5 to 1 microampere.

Observation of the particles emitted at 90° to the beam when the Li^7 beam impinged on a LiF target disclosed a group of particles of approximately 50-cm range in air. Using other targets of separated lithium isotopes, a study of the numerous reactions produced by either the Li^6 or the Li^7 beam showed that the group arose from the Li^7-Li^7 combination. The detector was a CsI(Tl) scintillating crystal 0.5 mm thick attached to a photomultiplier tube, and ranges were studied by inserting aluminum foils between target chamber window and crystal detector. Pulse heights were recorded on a 6-channel analyzer. The yield of these protons was about 28 per unit solid angle at 90° in the laboratory system, per microcoulomb of Li^7 ions on a thick target of LiF.

The entire target chamber and its rigidly attached crystal-photomultiplier assembly could be removed and attached to our Cockcroft-Walton accelerator. Thus the new group was compared with a 58-cm proton group from $B^{10}(d,p)B^{11*}$, whose energy, at 90° from a 400-kev deuteron beam, is known[5] to be 6.802±0.008 Mev. Portions of the range-energy curves for both proton groups were constructed by plotting pulse height *versus* mg/cm² of aluminum inserted. The identity in slope of the new curve with that of the known protons from boron shows that the new particles from Li are protons. The two curves were displaced by 12.35±0.4 mg/cm² of Al, or 8.35±0.3 cm air, and using the slope of the proton range—energy curve in this region we find 6.23±0.03 Mev for the energy of the new proton group.

Using published mass values,[6] it results that the Q-value of the new $Li^7(Li^7,p)B^{13}$ reaction is 5.97±0.03 Mev, giving B^{13}, presumably in its ground state, a value of $(M-A)$ equal to 20.39±0.03 Mev, or a physical atomic weight of 13.02190±0.00003. This agrees with the value of 19±2 Mev for $(M-A)$ predicted by Barkas.[2]

A search for the β activity and possible delayed neutrons will be made. Thanks are due Walter Mankawich for careful construction of the electrostatic analyzer and I. S. Iwaoka for operation of the Van de Graaff accelerator.

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Ultrasonic Saturation of Nuclear Magnetic Energy Levels*

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RECENTLY, Proctor and Tanttila have described an experiment in which pure nuclear electric quadrupole energy levels were saturated by ultrasonic excitation at the pure quadrupole transition frequency.[1] In a similar experiment we have observed a change in the population of the nuclear magnetic energy levels of Na^{23} in a single crystal of NaCl as a result of ultrasonic excitation. The cubic symmetry of the NaCl crystal is removed by the sound, causing time varying electric field gradients at the Na^{23} nuclei which interact with their quadrupole moment. This may induce transitions corresponding to m changes of both ±1 and ±2. In our experiment, the sound frequency was twice the magnetic resonance transition frequency, which corresponds to $\Delta m=\pm2$. Our experiment was performed in a steady magnetic field of 4220 oersteds, under which conditions the nuclear magnetic resonance occurred at a frequency of 4.75 Mc/sec. We measured the thermal relaxation time to be 8 seconds at room temperature.

In a magnetic field, Na^{23} has four nuclear magnetic energy levels corresponding to m values of $-\frac{3}{2}$, $-\frac{1}{2}$, $+\frac{1}{2}$, and $+\frac{3}{2}$. There are 3 transitions between these and they are at identical frequencies in ideal NaCl crystals. In this experiment the population difference between the $m=+\frac{3}{2}$ and $m=-\frac{3}{2}$ levels was measured by the amplitude of the nuclear induction signal that followed a short pulse of radio-frequency magnetic field at the Larmor frequency.[2] The nuclear signal was induced in a receiver coil oriented perpendicular to the transmitter coil and containing the NaCl crystal sample. The sample was a cylinder of halite 1.5 cm in diameter and 3 cm long. It was cemented to an identical crystal which in turn was cemented to an X-cut quartz transducer. The quartz had a broad resonance centered at 9.5 Mc/sec when loaded and was driven by a variable frequency oscillator. This oscillator was turned on for a period of 8 seconds; then after a delay of 0.03 sec the $+\frac{3}{2}$, $-\frac{3}{2}$ population difference was measured. This cycle was repeated every 17 seconds. We assume that the sound generated by the quartz was scattered into an isotropic distribution at the free end of the halite sample since this end had been made irregular. The magnetic fields generated by currents in the ultrasonic system, a possible source of difficulty in the experiment of Proctor and Tanttila, could not affect the population since they were at twice the Larmor frequency.

We observed a decrease in the $m=+\frac{3}{2}$, $m=-\frac{3}{2}$ population difference for a small range of ultrasonic frequencies centered exactly at twice the nuclear