shown. These are plotted against the applied field and the corresponding values of internal field as determined from an experimental $B-H$ curve are shown on the auxiliary scale. The extra absorption peaks are repeatable and are being investigated in detail.

By placing the disk at the center of the cavity at the electric field maximum we obtain the real and imaginary dielectric constant of the same sample.

We should like to thank Dr. A. M. Clogston for his assistance in this investigation.

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Hollow Dislocations and Etch Pits

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Some time ago Frank[1] showed that dislocations having large Burgers vectors should be hollow. The present letter considers the conditions necessary to open up any dislocation (forming an etch pit) by placing the crystal in an undersaturated medium. The idea is simply to generalize Frank's analysis (limited to equilibrium conditions) to the general case of growth or evaporation. Let us consider a crystal containing a hollow dislocation of radius r and Burgers vector b. The crystal is *not* in equilibrium with the surrounding medium, and the decrease in free energy of the system by the formation of a unit volume of crystal (supposed perfect) is ΔG_v. If $\Delta G_v>0$, the crystal is growing; if $\Delta G_v<0$, the crystal is evaporating.

Then an increase by dr of the radius of the hollow will produce a change dG in the free energy of the system, per unit length of dislocation, equal to

$$dG=\Delta G_v 2\pi r dr+\gamma 2\pi dr-(\mu b^2/8\pi^2 r^2)2\pi r dr,$$

where γ is the crystal-medium surface energy, and μ the shear modulus. The value of r satisfying the condition $dG/dr=0$ will correspond to a steady state situation where the radius of the hollow remains constant, while the crystal grows or evaporates. This value of r is given by

$$r=\tfrac{1}{2}\rho_c\{[1+4(r_0/\rho_c)]^{\frac{1}{2}}-1\},$$

where $\rho_c=\gamma/\Delta G_v$ is the critical radius for two-dimensional nucleation on the surface of the crystal and $r_0=\mu b^2/8\pi^2\gamma$ is the radius of the hollow when the crystal is in equilibrium with the surroundings.

If $\rho_c>0$ ($\Delta G_v>0$), the hollow tends to close up as ρ_c decreases (ΔG_v increases). If $\rho_c<0$ ($\Delta G_v<0$), the hollow tends to open up giving a steady-state solution as long as $|\rho_c|$ is larger than the critical value $|\rho_c'|$ given by

$$\rho_c'=-4r_0.$$

For larger undersaturations the surface energy is not large enough to keep a constant radius for the hollow, and the etch pit is formed. If the surrounding medium is either vapor or dilute solution, $\Delta G_v=(kT/\Omega)\ln(p/p_0)$, where Ω is the molecular volume and p_0 the saturated pressure or concentration; the critical undersaturation ratio p_0/p_c is then given by

$$\ln(p_0/p_c)=2\pi^2\gamma^2\Omega/kT\mu b^2. \quad (1)$$

There is qualitative evidence for the critical opening up of a dislocation in the dissolution of CdI_2 crystals where the Burgers vectors are quite large (for instance, in the General Electric motion picture film). More quantitative experiments to test formula (1) would be worthwhile. Concerning the formation of etch pits in dislocations of small Burgers vectors, it is clear that this is only possible in a medium in which γ is considerably below the value corresponding to the free surface of a crystal.

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Ferromagnetic Resonance in Iron-Nickel Alloys*

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An anomalous sharp dip in the g value of iron-nickel alloys in the range of 30 to 50 percent nickel in colloidal suspensions has been reported by Bagguley,[1] the g value for 40 percent nickel falling to 2.01. Ferromagnetic resonance experiments have been made on disk-shaped bulk samples in an effort to verify this variation in g value with changing nickel concentration. Wavelengths of 6 mm, 1.2 cm, and 3 cm were used. Little or no variation in g value was observed in the four samples of varying nickel concentration investigated.

Disks 0.450 in. in diameter and about 0.010 in. thick, prepared from cold-rolled strip recrystallized at 1080°C for four hours, were polished with jewelers rouge, annealed in vacuum for two hours at 800°C, cooled slowly, and electropolished in a hot phosphoric acid-chromic acid solution. A small hole was drilled in the wall of a rectangular microwave cavity and the samples were clamped firmly to this wall. The 3-cm and 1.2-cm experiments were made using a reflection-type cavity forming one arm of a magic-T bridge. In the 6-mm experiments a crystal harmonic generator driven by a $2K33$, K-band klystron was used as a

source of power, and a transmission-type cavity was used. The microwave absorption was measured in all cases by the magnetic field modulation method.

Two orientations of the plane of the sample with respect to the external field were used in the 1.2-cm measurements, one parallel to the field in fields of about 3000 oersteds and the other normal to the field in fields of about 22 000 oersteds. The two resonance conditions are given by:[2]

$$\omega=\gamma[H_0(H_0+B_s)]^{\frac{1}{2}},$$

and

$$\omega=\gamma(H_0-B_s),$$

where H_0 is the external field for maximum absorption corrected for finite sample thickness, B_s the saturation induction, and $\gamma=ge/2mc$. From these two equations B_s and g can be calculated. The 6-mm and 3-cm measurements were made with the plane of the sample parallel to the external field in fields of about 10 000 and 800 oersteds respectively and the g-value calculated using the value of B_s given by the 1.2-cm measurements. The results are given in Table I. Values of B_s measured by a force method on samples of the same composition are given for comparison. The fields were measured by a rotating coil fluxmeter calibrated with a free radical compound to an accuracy of 1 percent. The demagnetization factor correction of several hundred oersteds applied to H_0 in the 3-cm measurements limits the accuracy of these measurements to about 5 percent.

TABLE I. Summary of results. B_s is the saturation induction in kilogauss. ΔH is the full width between points of maximum slope in oersteds. $\perp$ and $\parallel$ refer to the orientation of the plane of the sample with respect to the external field.

		Percent nickel			
		36	40	44	48
1.2 cm	g	2.12	2.14	2.14	2.13
	B_s	15.0	15.7	15.7	16.3
	$\Delta H_\perp$	225	200	200	175
	$\Delta H_\parallel$	125	125	125	125
6 mm	g	2.10	2.08	2.11	2.08
	$\Delta H_\parallel$	250	250	250	250
3 cm	g	2.2	2.2	2.3	2.3
	$\Delta H_\parallel$	120	120	90	90
Force method	B_s	15.2	15.7	16.2	16.0

The width of the resonance lines is surprisingly narrow in contrast to the widths reported for spheres in colloidal suspension.[1] The width of the 3-cm lines corresponds to a half-width at half-power points of from 100 to 80 oersteds for a Lorentzian curve, compared to 1000 to 250 oersteds reported for the colloidal spheres.[1] These are believed to be the sharpest ferromagnetic resonance lines to be reported for metals. The anisotropy fields are quite low in these alloys, $2K_1/M_s$ varying from 35 to 16 oersteds, thus their contribution to the line width is negligible.

It is seen that the bulk measurements here reported give no sign of the variation in g value with changing nickel concentration as seen in the colloidal spheres. The discrepancy might lie in the fact that it is difficult to determine g values accurately from very broad lines such as Bagguley reports.[1]

We should like to express our thanks to Professor C. Kittel for suggesting this experiment and for several helpful discussions; to Professor A. F. Kip for many helpful suggestions regarding the measurements; to Mr. Tom Hazelett for annealing the samples; and to Mr. Glen Wagoner for his assistance with the 3-cm measurements. The metallurgical work and magnetic measurements were made at the Westinghouse Research Laboratories and the ferromagnetic resonance experiments were carried out at the University of California.

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Resonances in the Proton Bombardment of C^{14}

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THE $C^{14}(p,\gamma)N^{15}$ reaction has been studied from 0.25 to 1.8 Mev by means of the Chalk River electrostatic accelerator. We wish to report a broad resonance observed in this reaction at a proton energy of 1.50 Mev which has not been reported in studies of the $N^{14}(n,n)$, $N^{14}(n,p)$, or $C^{14}(p,n)$ reactions.[1] Targets of elemental carbon, containing 25 percent C^{14} on tantalum backings, were prepared by heating the backings by induction to a bright red heat in the presence of CO gas containing radioactive carbon.

The yield curve of the ground state γ ray between proton energies of 0.9 and 1.7 Mev is shown in Fig. 1. These results were obtained in two experiments using two NaI(Tl) crystals 2 inches long by 2 inches in diameter mounted at angles of 0° and 90° to the direction of the proton beam in the first experiment and at angles of 143° and 90° in the second experiment. The neutrons from the $C^{14}(p,n)N^{14}$ reaction were also observed at 90° in each experiment. They were detected in a BF_3 counter surrounded with paraffin. The γ-ray yield curve has also been observed at 90° by Spearman, Hudspeth, and Morgan,[2] and the neutron yield curve by Roseborough, McCue, Preston, and Goodman.[3] The γ-ray yield exhibits a broad resonance with a maximum near a proton energy of 1.5 Mev. This resonance is only just discernible in the yield curves of the $C^{14}(p,n)N^{14}$ and the $N^{14}(n,p)C^{14}$ reactions where presumably it is