Letters to the Editor

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Single Crystal Metal Rotors*

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IN connection with studies of the tensile strength and adhesion of thin metal films by the spinning rotor method,[1] it became desirable to use single crystals of iron as high speed rotors. At first sight this might seem impractical because a crystal of iron at room temperature has a body-centered cubic structure and is very easily distorted along the (110), (112), and (123) slip planes.[2] However, the three planes have the same [111] direction of slip, so that if the stresses in the rotor along this direction could be sufficiently reduced, the rotor could be spun to high speed without distortion. An iron crystal carefully machined to a spherical shape (diameter 0.163 in.) was magnetically suspended in a vacuum and spun by a rotating magnetic field by a method previously described.[3] The sphere had a small flat milled on its surface perpendicular to the slip direction, which automatically constrained the rotor to spin about an axis parallel to the direction of slip. The rotor showed no observable distortion until it attained a rotational speed of about 19 000 rps when it became deformed. This deformation increased the moment of inertia, which in turn slowed down the rotor and allowed it to be brought to rest without destruction. The distortion was asymmetrical and mostly at an angle to the axis of rotation. The resultant rotor is shown in Fig. 1 with the small surface up which initially was flat. It was difficult to determine the initial slip planes from an examination of the resultant rotor as well as to calculate the maximum rotor stress. However, if we assume that the rotor was elastic up to maximum speed, the maximum stress was about 30 000 lb/in.^{2} while the maximum stress along the axis was about 1800 lb/in.^{2}. Both of these values are perhaps too high, but in any case a spherical single crystal of iron may reach considerable rotational speed if spun around the slip direction.

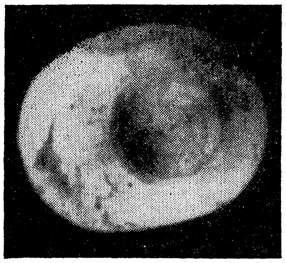

FIG. 1. Single crystal iron sphere with small flat after distortion by spinning.

Since the body-centered cubic structure of iron made the interpretation of the above experiment difficult, a single crystal of zinc was next spun around a perpendicular to its only slip plane (0001). The zinc crystal was a short cylinder 0.6215 in. in diameter and 0.23 in. high with the (0001) slip plane parallel to the ends of the cylinder to better than 0.5 degree as determined by x-ray reflection. It was carefully machined and etched to remove the majority of strains. Zinc is not ferromagnetic, so it was spun by the air turbine method.[4] The crystal was so mounted that it was free to expand except for a few thousandths of an inch on each end of the cylinder. It was spun to various speeds of rotation and held for one minute before being brought to rest for examination. No change was observed until the rotor speed reached about 1600 rps (2750 lb/in.^{2}), when microscopic examination indicated some faint lines developing on the cylindrical surface at least at two angles to the axis of rotation. At 2300 rps (5800 lb/in.^{2}) the slip bands became distinct and an increase in the diameter of 0.003 in. was observed.

The above results may be interpreted as indicating that if a crystal at room temperature is prevented from slipping along the usual slip planes, at sufficiently high stresses slip will take place along other planes. Also in some cases twinning may possibly take place. These results probably should be expected from well-known experiments on the slip in crystals.[2,5] However, in the experiments here described the maximum stresses are at the center of the crystal and approach zero or a small value on the crystal surface. Also, in the case of iron, the crystal is not constrained in any way by clamps, etc., while in zinc the constraints are made very small.

The writer is much indebted to Drs. Allan Gwathmey, Fred Young, and Henry Leidheiser for the excellent iron and zinc crystals.

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[1] Beams, Walker, and Morton, Phys. Rev. **87**, 542 (1952).

[2] C. S. Barrett, *Structure of Metals* (McGraw-Hill Book Company, Inc., New York, 1952), second edition.

[3] Beams, Young, and Moore, J. Appl. Phys. **17**, 886 (1946).

[4] J. W. Beams, J. Wash. Acad. Sci. **37**, 221 (1947).

[5] W. T. Read, Jr., *Imperfections in Nearly Perfect Crystals* (John Wiley and Sons, Inc., New York, 1952).

Hall Effect in AgCl at Low Temperature*

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THE method of Redfield[1] for detecting the Hall effect in insulating crystals has been applied to silver chloride. Measurements of Hall mobility were made at liquid nitrogen temperature on a specimen cut from a single crystal carefully grown from the melt. Crystal counter techniques using high-energy beta particles had previously yielded estimates of the drift mobility as a function of temperature in this crystal.[2]

Difficulty was experienced in directly applying the Redfield method to AgCl because of low-frequency noise and drift. A pulse technique was developed in which the photoconducting crystal was illuminated with a 15-microsecond flash of light from a strobotron. This was synchronized with the maximum of a much slower electric field pulse applied to the resistance film (in this case a relatively low resistance evaporated platinum film). Charge flow in the crystal was detected by a non-overloading linear amplifier and an oscilloscope. The repetition rate of the pulses was low, of the order of one every few seconds. Since the electric field applied to the crystal was zero, except during the pulse, depolarization could be effected by low-intensity steady illumination. A thin Mylar film separated the crystal and electrodes and prevented the possibility of charge entering the crystal from the electrodes. An analysis of the experiment shows the importance of releasing charge uniformly throughout the volume of the crystal. This was accomplished by filtering the light with an orange filter having a cutoff at 5200A. Care was taken to properly ascertain the true temperature of the crystal as it was mounted in the cryostat.

In itself the fast-pulse technique appears to be useful for studying photoeffect and polarization. Induced charges of the

FIG. 1. Single crystal iron sphere with small flat after distortion by spinning.