and distribution of dislocations in a deformed metal.

We have recently found[8] in case of deformed filings of several HCP metals that the flow stress values calculated from dislocation densities obtained by similar X-ray analysis are approximately equal to the yield strengths of the well-annealed metals. The values of flow stress (τ) in cold-worked and partially annealed filings of tungsten calculated in the same way from the relation

$$\tau = 0{\cdot}3\ bG\ (\rho_t)^{\frac{1}{2}} \qquad (6)$$

(where G is the shear modulus) are listed in Table I. The top curve of Fig. 3 shows the variation of τ with temperature.

The yield stress (YS) in tungsten has been found to be markedly sensitive to the strain rate. For example, increase in strain rate from about $10^{-5}sec^{-1}$ to about $10^{-2}sec^{-1}$ raises the YS by a factor of 3 (Betchold[9]). When extrapolated to a strain rate of $10^{-1}sec^{-1}$ the YS is approximately 80,000 psi at 250° C, which is in good agreement with our extrapolated value of τ at 250° C (Fig. 3). Thus, it may be concluded that the flow stress in drastically deformed tungsten (filings) calculated from equation (6) is approximately equal to its yield strength measured with a very high strain rate ($\sim 10^{-1}sec^{-1}$).

Also shown in Fig. 3 are the values of flow stress for tungsten as a function of temperature for different strains at a constant rate of extension ($2{\cdot}8 \times 10^{-4}sec^{-1}$) from the data of Betchold and Shewman.[10] Filing is a drastic form of deformation both in terms of strain and strain rate, thus τ (for filings) can be considered to represent the flow stress for an extremely high strain value. This is supported by the results shown in Fig. 3, since the plot of τ *vs.* temperature as per our X-ray data lies above the curve for flow stress *vs.* temperature at the highest strain ($\delta = 0{\cdot}05$). If we plot the flow stress values against natural strain (δ) from Fig. 3, our values are found to approximate to flow stress values extrapolated for $\delta = 0{\cdot}1$.

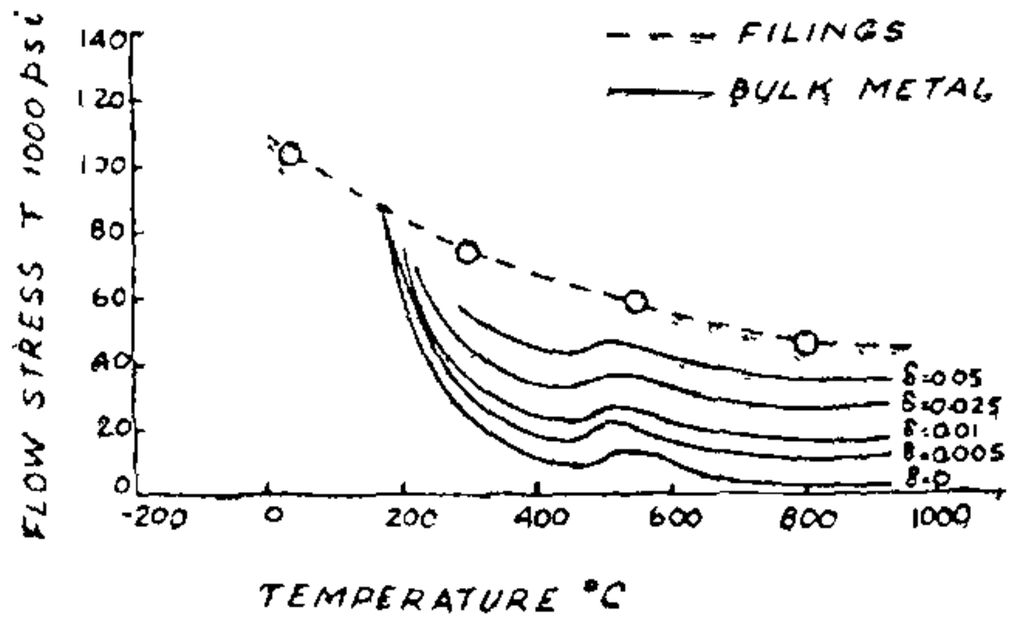

FIG. 3. Effect of temperature on flow stress of (*a*) cold worked and partially annealed tungsten filings (present work) and (*b*) annealed tungsten with different strain at the constant extension rate of $2{\cdot}8 \times 10^{-4}sec^{-1}$ (from the data of Betchold and Shewman).

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E.S.R. STUDIES ON GLYCINE COMPLEXES OF MANGANESE CHLORIDE AND MANGANESE BROMIDE

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DIGLYCINE Manganese Chloride dihydrate $(NH_2CH_2COOH)_2.MnCl_2.2H_2O$ (hereafter referred to as G_2MCD), is one of the very few paramagnetic substances showing ferroelectric nature at room temperature. Pepinsky *et al.*[1] studied the dielectric properties of this crystal from 345° K to 77° K. Beyond 328° K, it loses its water of hydration. In the above range of temperature, they could not find the Curie temperature, Θ. E.S.R. studies on this compound have been taken up by us with a view to estimate the Curie temperature and the

exchange energy (J). The corresponding manganese bromide complex of glycine which is a non-ferroelectric substance, namely, Di-glycine Manganese bromide trihydrate (referred to as G_2MBT) was also taken up for study, for comparison.

The crystals of G_2MCD and G_2MBT were prepared by the method of evaporation from aqueous solutions containing two molecular weights of glycine and one molecular weight of the corresponding manganese compound. The formation of the above compounds was confirmed by measuring their density and water of hydration. In the case of G_2MCD the unit cell dimensions were checked by preliminary X-ray data. In Table I are shown the data for the two crystals.

TABLE I

Substance	a	b	c	β	Density (ρ)	Space group	Molecular weight (M)	No. of molecules in the unit cell
D_2MCD ..	9·96	8·53	6·86	107°	1·875	P_{21}	315	2
D_2MBT ..	11·10	6·12	9·65	91°	2·23	$P_{21/c}$	416	2

The first derivative of the E.S.R. signals of the above crystals and their powders were recorded with an E.S.R. spectrometer assembled in this laboratory, having 100 KHz magnetic field modulation arrangement. The details of the spectrometer are given elsewhere.[2] The cavity used was a H_{012} metallic cavity and the modulation loop was arranged at the central hole of the cavity. The substance was placed in a small glass tube and introduced in the cavity at its centre.

Anderson and Weiss[3] have calculated the isotropically narrowed line widths of undiluted paramagnetic substances assuming a simple cubic lattice. The formula for line widths as corrected by Locher and Gorter[4] is given by

$$\Delta H_{\frac{1}{2}} = 2\left[\frac{10}{3} \cdot \frac{H_p^2}{H_e}\right] \qquad (1)$$

where H_p and H_e are the dipolar and exchange interactions given by

$$H_p^2 = 5{\cdot}1\left[g\beta\frac{N\rho}{M}\right]^2 S\,(S+1) \qquad (2)$$

$$H_e = [2{\cdot}83\ S\,(S+1)]^{\frac{1}{2}}\frac{2J}{g\beta} \qquad (3)$$

g is the spectroscopic splitting factor, β is the Bohr magneton, N is the Avogadro number, ρ is the density of the crystal, M is the molecular weight, S is the spin quantum number and J is the exchange integral. The Curie temperature (Θ) is obtained by the formula

$$3K\Theta = 2JZ\,S\,(S+1) \qquad (4)$$

where K is the Boltzmann constant and Z is the number of the nearest neighbours taken to be 6.

This theory can be applied to the powders in the case of Mn^{2} and Fe^{3+} compounds where anisotropy broadening is small. Kumugai *et al.*[5] compiled the line widths for a number of Mn^{2} and Fe^{3+} compounds taken in the powder form only. In the present experiment, the first derivative signals of the E.S.R. spectra on the powders of G_2MCD and G_2MBT were recorded. From the above signals, the peak to peak value of the line widths (ΔH_{pp}) for the above compounds are found to be 485 Oersteds and 112 Oersteds respectively. Assuming the line shapes to be Lorentzian, the full line widths at half power points are calculated from the formula

$$\frac{\sqrt{3}}{2}\Delta H_{pp} = \Delta H_{\frac{1}{2}}. \qquad (5)$$

The g values of the two complexes are the same having a value of 2·04.

Using the formulae from (1) to (5) the values of $\Delta H_{\frac{1}{2}}$, H, H_e, J and Θ are calculated and are given in Table II.

TABLE II

Substance	$\Delta H_{\frac{1}{2}}$	H_p in oersteds	H_e in oersteds	J in cm^{-1}	Curie temp. (Θ), in °K.
D_2MCD ..	420	454	3272	0·03439	1·734
D_2MBT ..	97	408	11450	0·1088	5·522

The value of J for G_2MCD is comparable with the values for other managanese compounds reported in the literature, while that of G_2MBT is very much larger. Moreover, the line width of G_2MBT is abnormally small. From the above result it can be concluded that the distance between neighbouring paramagnetic ions in D_2MBT may be much smaller than for the other maganese compounds, resulting in

a larger exchange interaction energy. This can be confirmed when a complete X-ray analysis of the crystal is undertaken. Further work on the line width variation with temperature on single crystals of these two compounds is in progress.

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INDUCED APHID RESISTANCE IN *BRASSICA JUNCEA* COSS.

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ABSTRACT

In two commercial varieties of *Brassica juncea,* Laha 101 and R.L. 18, treated with different concentrations of the mutagens, ethylmethane sulphonate (EMS), maleic hydrazide (MH), ethylene imine (EI), diethyl sulphate (DES) and different dozes of gamma-rays, several plants highly resistant to the attacks of the aphids, *Lipaphis pseudobrassicae* (Davis), were isolated in the M_2 generation. The two varieties responded differently to the different mutagens, EMS and gamma-rays inducing more aphid resistant mutations in Laha 101 and HA and EI in R.L. 18. As aphid resistance may not be a case of simple inheritance effective control over the pest could be achieved by concentrating the resistant genes in a single strain.

INTRODUCTION

AN important part of any project of insect control is the search for the sources of resistance and utilize them in reducing the population of insects and the damage done by them. If the resistance genes are found in distantly related species and genera the problems of crossability, hybrid inviability and linkage of undesirable characters, usually accompanying distant hybridization, may render exploitation of such genes almost impossible. One is, therefore, faced with the problem of looking for resistance within the limits of the species. Where naturally occurring resistance genes are very few or not yet discovered within the parameters of a species, artificial induction of mutations for such characters assumes importance. However, at the present status of our knowledge the chances of getting such mutations cannot be predicted.

Of the three species of aphids, the cabbage aphid (*Brevicoryne brassicae* L.), the green peach aphid (*Myzus persicae* Sulz.) and the false cabbage aphid [*Lipaphis pseudobrassicae* (Davis)], known to attack the plants of the cabbage family, the last one is important in India as it is known to have completely wiped out the oleiferous *Brassica* crop in years of severe infestation. Besides directly devastating the plants the aphids also act as vectors to virus diseases.[4] In an aphis resistant rape (*B. napus* L.)[5] developed by crossing a swede hybrid (Calder × Superlative) with club root resistant rape the gene for resistance to cabbage aphid came from the Calder swede. There was a clear difference in the rates at which the aphids increased in the resistant and susceptible varieties[3] and in trials the resistant rape gave 50% more yield.[4] It was, however, not resistant to either the green peach aphid or to the false cabbage aphid. Under artificial conditions of infestation *B. napus* was found to be resistant and *B. Tournefortii* and *Eruca sativa* tolerant to the false cabbage aphid.[6] A glossy mutant of kale (*B. oleracca* var. *acephala*) was found to be resistant to cabbage aphid.[9] It is thus seen that there are very few aphid resistant genes in the genus *Brassica.*

EXPERIMENTAL RESULTS AND CONCLUSIONS

Seeds of two commercial varieties of *B. juncea*, Laha 101 and R.L. 18 were treated with three different concentrations of the mutagens, ethylmethane sulphonate (EMS), maleic hydrazide (MH), ethylene imine (EI), and diethyl sulphate (DES) and also irradiated