For finite plastic deformations, E.T. Onat also found that state variables are necessary. J. F. Besseling wanted that a distinction be made between thermodynamical systems and those dealing with boundary value problems. He showed that a continuum theory of deformation and flow can be based on the principle of conservation of mass, the two laws of thermodynamics, the concepts of a local thermodynamic state and a local geometric natural reference state, a principle of determinism and on a postulate concerning the production of entropy.

Thermodynamical effects and irreversibility in elastic-plastic problems, creep and rupture were discussed by W. Prager, E. H. Lee, P. M. Naghdi, G. S. Shapiro, B. R. Seth, Ju. N. Rabotnov, Jan Hult, M. Reiner and others. B. R. Seth showed that, contrary to current concepts conditions of state and jump conditions could be obtained from the field equations by treating them as asymptotic solutions at the transition points of the differential system defining the field. He showed how jump conditions for shock waves, yield conditions for elastic-plastic deformation and creep conditions like those of Norton's law could be obtained.

W. Nowacki extended the coupled-stresses theory of thermo-elasticity to that of a homogeneous Cosserat's medium and obtained a generalization of the Galerkin method for the corresponding dynamical system. An accumulating second order effect on strain-hardening aluminum specimens in reversed torsion was pointed out by A. M. Freudenthal and M. Ronay. This should be treated as a transition phenomenon and not explained by a particular type of constitutive equation. M. J. Lighthill discussed the interesting example of a Cosserat's fluid medium having a gas bubble.

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# RADIAL PARTICLE PROFILE IN NEGATIVE GLOW NEON PLASMA

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IN a steady-state plasma, where the losses of charge carriers are governed mainly by the diffusion processes, the general particle balance equation can be put as:

$$D_a \nabla^2 n_e + \nu_i n_e = 0 \qquad (1)$$

where $D_a$ = coefficient of ambipolar diffusion; $\nu_i$ = rate of collisional ionization referred to an average plasma electron, and $n_e$ = plasma electron density. Here it is assumed that the dominant process of secondary ionization in the plasma volume is due to electron collisions and is therefore dependent on the density $n_e$. The solution of (1) for the case of a cylindrical plasma, considering only the radial boundary conditions, was shown by Schottky[1] to give a distribution represented by a Bessel function.

$$n_r = n_0 J_0 (br) \qquad (2)$$

where $b = (\nu_i/D_a)^{\frac{1}{2}}$ and $n_0$ = particle density along the tube axis. Schottky's theory was given for the positive column part of the plasma where the motions of the charge carriers are sufficiently randomized. The negative glow plasma in a highly abnormal discharge is mainly generated by an approximately monoenergetic beam of electrons arriving from the cathode fall region. If the energy of the incoming electrons is very high compared with the average energy lost in an ionizing collision, the secondary ionization rate in the negative glow space becomes uniform and independent of the particle density $n_e$. Such a situation, as pointed out by Persson,[2] leads to a well-behaved laboratory plasma. For a uniform electron beam with energy enough to make the reaching distance[2] $L >> R$ ($R$ = radius of container) and to cause ionization at a constant rate along its length, the charge carriers so produced are lost either by ambipolar diffusion or by volume recombination. Persson[2] has shown that the radial particle profile for the diffusion limited case (neglecting recombination) is parabolic in form.

We have observed the radial density profile in Neon ($p = 260\,\mu$; $i_{dc} = 4\cdot5$ mA; $V_{dc} = 1160$ V) by the double-probe method,[3] when both the probes were in the negative glow plasma; the plasma was generated in a cylindrical discharge tube (Pyrex, radius $R = 1\cdot3$ cm.). The exploring probe was moved radially from the geometrical position of the wall to the axis of the tube by a micrometer screw movement.

Following Persson, we assume an expression of the type

$$\frac{n_r}{n_o} = A\left[B - \left(\frac{r}{R}\right)^2\right] \quad (3)$$

where A and B are constants which can be determined from the boundary conditions, $n_r = n_R$ at $r = R$ and $n_r = n_0$ at $r = o$. $n_R$ represents the observed particle density when the movable probe occupies the geometrical position of the wall. Equation (3) can then be written as

$$\frac{n_r}{n_o} = (1 - N)\left[\left(\frac{1}{1-N}\right) - \left(\frac{r}{R}\right)^2\right]$$

where $N = n_R/n_0$. For the present case $n_R = 1 \cdot 72 \times 10^9$ cm.$^{-3}$ and $n_o = 2 \cdot 88 \times 10^9$ cm.$^{-3}$, which gives the values of the constants as $A \doteq 0 \cdot 4$, $B = 2 \cdot 5$. Figure 1 (solid curve) gives the corresponding distribution. The Bessel function profile for the same experimental data is given in Fig. 2 (solid curve) which is calculated on the basis that $n_R \neq o$ but has the value observed with the help of the movable probe as mentioned above. Thus it can be seen from Figs. 1 and 2 that the observations appear to be capable of representation both by a parabolic distribution as well as by a Bessel function. This fact can be interpreted to mean that ionization is not restricted to only the high energy electrons ($\approx$ monoenergetic) coming from the cathode dark space. It appears therefore that the negative glow plasma investigated has a status intermediate between that of a positive column plasma and a negative glow beam plasma (where the parabolic distribution alone should be valid).

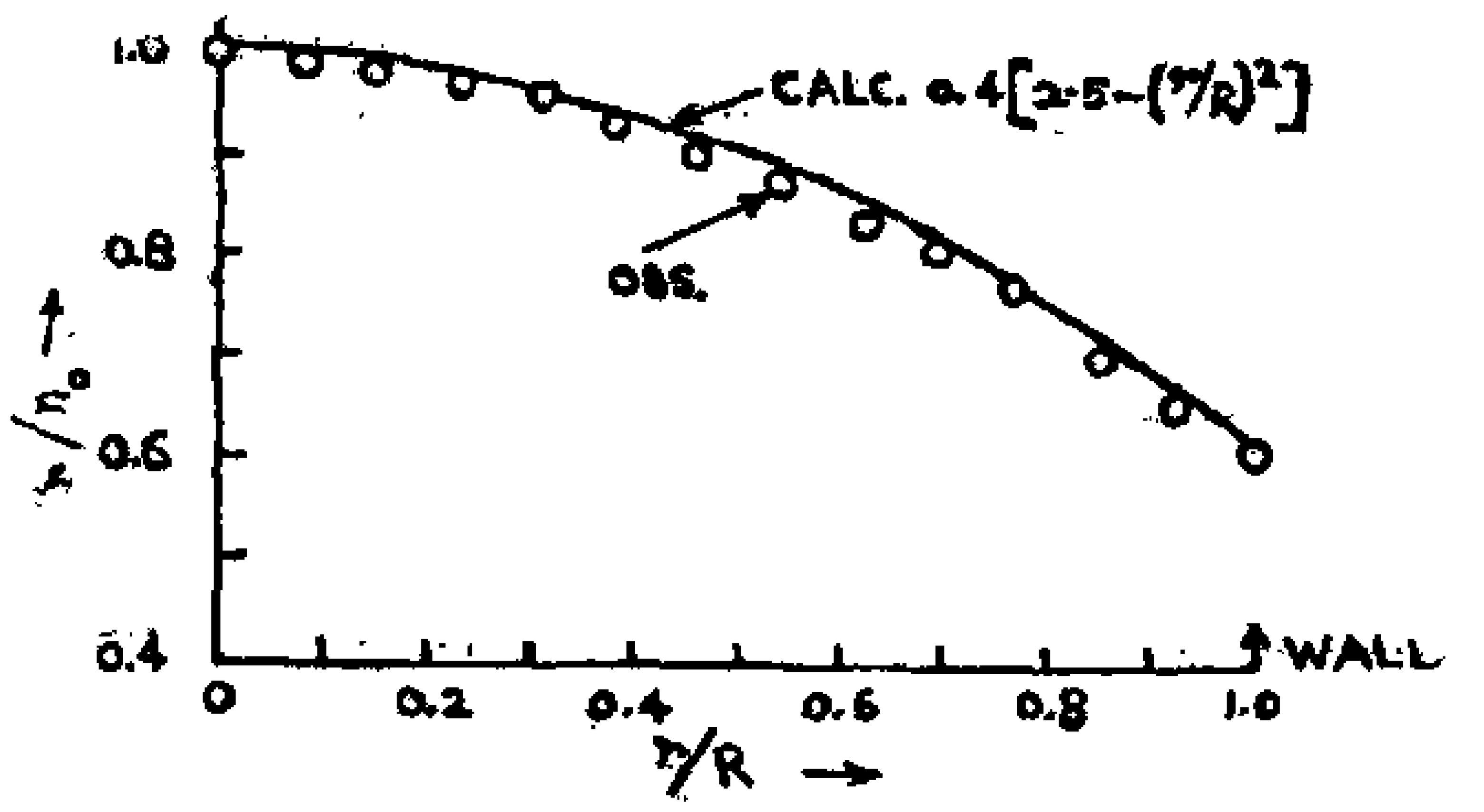


FIG. 1. Radial particle density profile in the negative glow neon plasma compared with parabolic function.

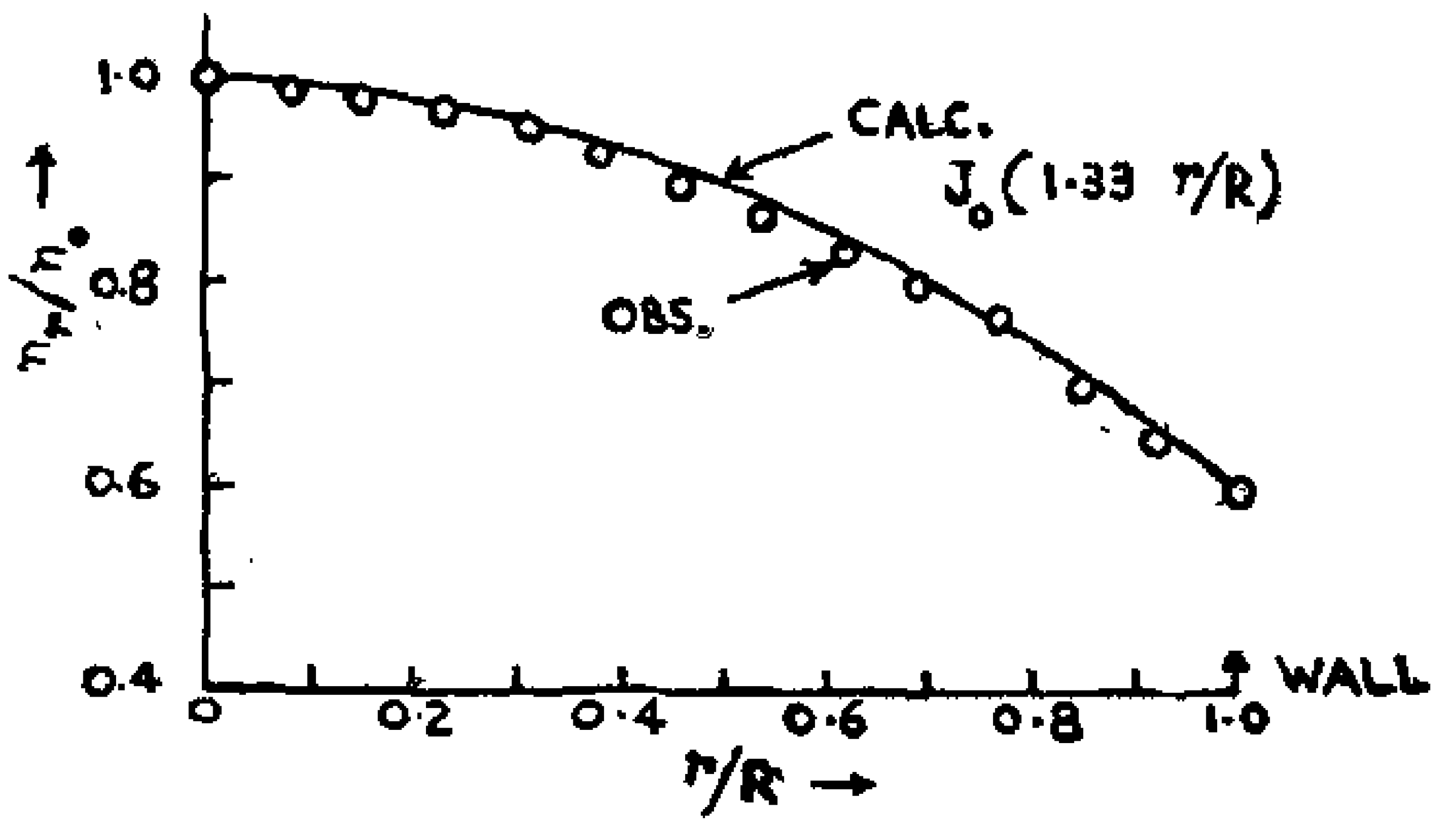


FIG. 2. Radial particle density profile in the negative glow neon plasma compared with Bessel function.

One of us (Y. R. D.) is indebted to the Government of Maharashtra for the award of a Junior Research Followship.

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## X-RAY ANALYSIS OF IMPERFECTIONS IN DEFORMED RHODIUM

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BROADENING of X-ray powder reflections from cold-worked rhodium was first analysed by Brindley and Rindley[1] and the conclusion drawn that lattice strain alone contributes to the observed broadening. No further attempt has, however, been made in the last two decades to examine the possible incidence of stacking faults on deforming rhodium and to separate quantitatively the contributions due to domain size and lattice strain. The present note deals with an accurate determination of deformation stacking faults in cold-worked rhodium powder and an evaluation therefrom of the values of domain size and lattice strain.

High-purity (> 99·99%) rhodium powder was deformed at room temperature for an hour in a mechanical pulveriser and was then pressed in the form of briquettes for mounting in a Philips X-ray Diffractometer. Line profiles of the (111), (200), (311) and (222) reflections were recorded from such briquettes at a scanning rate of 1/8° per minute and a time constant of 4 seconds. The briquette was then annealed in vacuum and the same line profiles recorded