location of the three segments of the primary locus in the v'–v'' plane.

Possible segments of the p'th subsidiary locus are those implied in equations 4*a*–4*f* which cover all possibilities of equation (2). The cases $r'_2(1) = r''_1(p)$ and $r'_2(p) = r''_1(1)$ are excluded by the hypothesis $r'_e > r''_e$

$$r'_1(1) = r''_1(p) \quad (4a)$$

$$r'_1(p) = r''_1(1) \quad (4b)$$

$$r'_1(1) = r''_2(p) \quad (4c)$$

$$r'_1(p) = r''_2(1) \quad (4d)$$

$$r'_2(1) = r''_2(p) \quad (4e)$$

$$r'_2(p) = r'_2(1) \quad (4f)$$

Fig. 2*a* and *b* illustrate the situation. Fig. 2*a* traces in the v–r plane the location of the principal and p'th antinodes of the wave-functions for each of the two potentials involved in the transition.

The vertical lines correspond to the respective conditions of equations (4*a*)–(4*f*). Fig. 2*b* illustrates the corresponding possible locations of segments of the p'th subsidiary locus.

A direct comparison between the Condon loci and the predicted position of the segments has been carried out for many band systems using the parabolic and Morse models of molecular potentials. For the parabolic model, Hermite wave functions are known analytically and have been tabulated by Pillow[4], while extensive tables of overlap integrals have been computed by Aiken[5]. For Morse potentials, extensive Franck–Condon factor arrays are available[6] together with tabulations of wave functions.

Comparisons were made between loci segment predicted by equations (3*a*)–(3*c*) and (4*a*)–(4*f*) and the actual loci evident both in computed Franck–Condon arrays and also

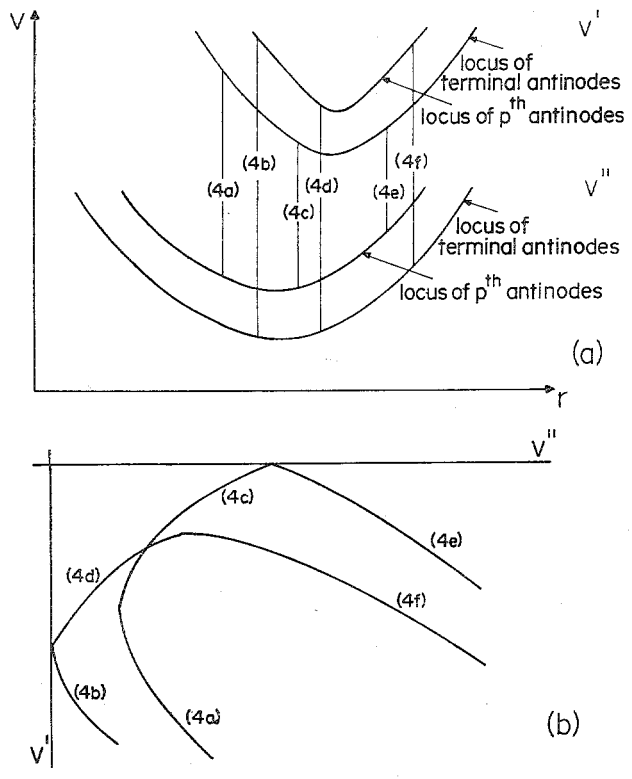

Fig. 2. Conditions giving rise to p'th Condon locus. (*a*) Terminal and p'th subsidiary antinodes at same internuclear separation. The curves are antinode loci in the v–r plane; (*b*) v'–v'', Deslandres plot from co-location of terminal and p'th antinodes. Designations (4*a*) etc. relate to equations in text.

in intensity distributions for thirteen representative band systems the Δr_e of which varied from nearly zero (gallium iodide) to 0·4 Å (molecular oxygen). Excellent agreement was found between the location of calculated segments and actual Condon loci in all cases except for those of very small and very large values of Δr_e, for both of which principal contributions are made to the overlap integral from more than one pair of overlapping wave-function loops. The size of each segment and its orientation and position depend largely on Δr_e, and to a lesser extent on other molecular constants.

The subsidiary loci closely follow the location of segments *a*, *c*–*d* and *f* when $r'_e > r''_e$, for there is additional constructive overlap between many of the wave functions.

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THE SOLID STATE

Domain Wall Motion in Double Nickel–Iron Films

Middelhoek and Wild[1] have recently measured mobilities for domain wall motion in double nickel–iron alloy which are significantly greater than those reported earlier by Patton and Humphrey[2] for similar films. Both groups have published mobility data for single layer films which are in good agreement[3,4]. In an attempt to clarify the situation concerning double films, mobility measurements have been made for two of Middelhoek and Wild's double films, each with two 400 Å nickel–iron layers (80 per cent nickel) separated by 100 Å of silica, using the technique reported previously[2,4]. For these films, a wall mobility value of 1·2 ($\pm$ 0·3) $\times$ 10^4 cm/sec-Oe was obtained. Middelhoek and Wild's mobility of $4{\cdot}1 \times 10^4$ cm/sec-Oe for double films (440 Å nickel–iron layers separated by 100 Å of silica) is significantly larger than the present determination. These differences are too large to be explained by the 40 Å difference in nickel–iron layer thickness or the scatter in the data. The differences in mobility determination for similar films from the same laboratory, as measured by different laboratories, can only be due to differences in the experimental technique.

For both techniques, single isolated domain walls are moved across the film using a number of short easy-axis field pulses of known duration and amplitude. Middelhoek's technique uses a large number (about 500) of very short pulses (20–800 nsec). The technique used by Patton and Humphrey[2,4], on the other hand, uses only a small number (1–50) of longer (10–100 μsec) pulses to produce the wall displacements. Presumably, for sufficiently short pulses, effects involving the wall mass and elastic wall displacements would make the velocity a function of pulse length. If these effects were important, Middelhoek's technique (using shorter pulses) would be expected to yield lower, not higher, mobilities than those reported by Patton and Humphrey. Both authors have, however, reported that the results do not depend on these parameters. For Middelhoek's technique, the wall geometry in the film is controlled by the field itself, produced by a stripline passing over the film. As wall motion proceeds

additional growth of a zig-zag wall structure occurs at both ends of the wall section under observation, at those points where the stripline field falls below the coercive force. For Patton and Humphrey's technique, the wall geometry is controlled by quality of the film. The easy-axis drive field is produced by a Helmholtz pair and is uniform over the entire film. The wall length must remain approximately constant (limited by the film edge) and no additional nucleation or growth of walls can occur in order for a meaning of mobility determination to be made.

At present, it is not clear why the two sets of mobility data for double films are different. Because the two techniques yield different results even for similar samples from the same laboratory, it appears that the differences result from the measurement technique. Because the mobility data for single layers are in agreement, however, these differences must involve some aspect of the technique peculiar to layered films.

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CHEMISTRY

Formation of Polycyclic Aromatic Hydrocarbons in Pre-mixed Acetylene–Oxygen Flames

An investigation has been made of the polycyclic aromatic hydrocarbons associated with the soot in pre-mixed acetylene–oxygen flames operating at a pressure of 20 mm of mercury. The burner, diameter 5·125 in., incorporated a water-cooled porous metal disk and enabled a flat-flame to be stabilized above it with an extended reaction zone. Water-cooled stainless steel grids were inserted into the flame at varying heights above the burner and samples of soot were collected.

At the specified pressure, an acetylene–oxygen ratio of about 0·95 just began to produce soot. Flames employed in the present work corresponded to acetylene–oxygen ratios of 1·2 and 1·5 respectively. The apparent temperatures (uncorrected) measured by means of a silica coated thermocouple probe of platinum and platinum/rhodium (87 : 13), the wires being 0·008 in. diameter, were recorded at varying heights and the results are plotted for flame 1 (acetylene/oxygen ratio = 1·2) in Fig. 1.

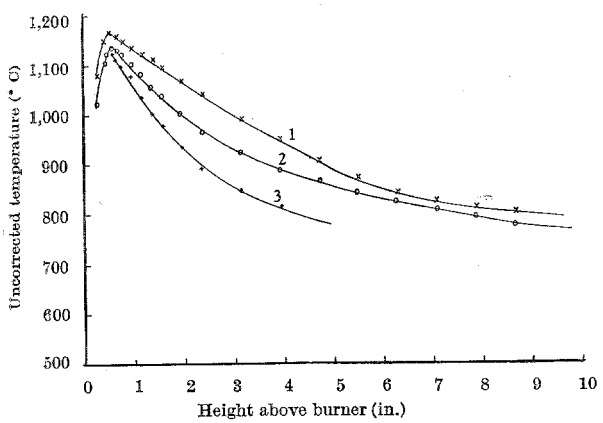

Fig. 1. Flame 1. Temperature of flame versus height above burner surface. 1, Axis of burner; 2, 1·1 in. from axis; 3, 2·0 in. from axis.

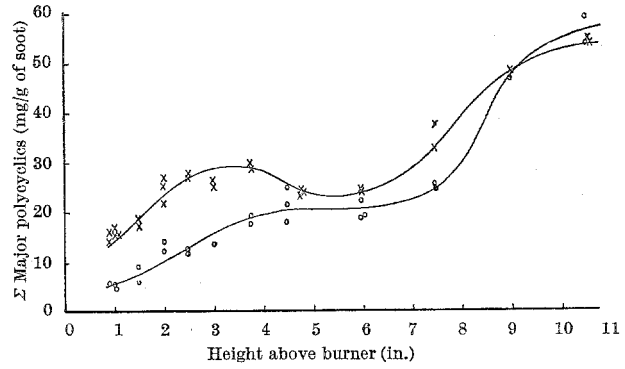

Fig. 2. Σ Major polycyclics in soots from flame 1 (○) and 2 (×) versus height above the burner.

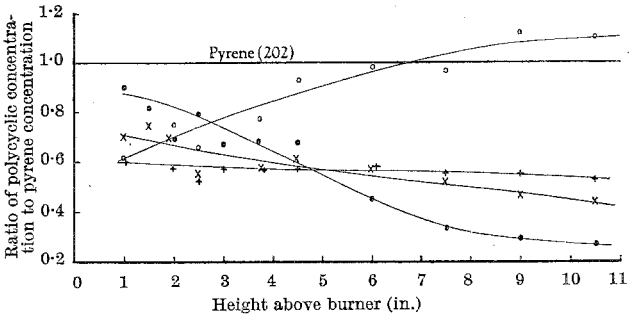

Fig. 3. Individual polycyclics in soot, expressed as ratio to pyrene versus height above the burner. Flame 1. ○, Chrysene (228) + 1,2-benzanthracene (228); +, 2,13-benzfluoranthene (226); ×, fluoranthene (202); ●, anthracene (178) + phenanthrene (178). Numbers after names are molecular weights.

Soot was removed from the collecting grid and extracted for 4 h with chloroform in a Soxhlet apparatus with a stream of nitrogen passing through it to prevent any air oxidation of extracted material. The extract was transferred to a 1 ml. flask using carbon disulphide as solvent.

Previous work in this laboratory had indicated that 12 ft. columns, 0·25 in. diameter, containing 10 per cent '*SE*–52' silicone gum rubber on 60–80 mesh 'Chromosorb *W*' as a stationary phase, were capable of giving good separations of individual polycyclic aromatic hydrocarbons when using an '*F* and *M* 810' research gas chromatograph with temperature programming from 190°–300° C at 4° C/min. Normally, flame ionization detectors were used for quantitative determinations, but for the identification of individual polycyclic aromatic hydrocarbons thermal conductivity detectors were used and the eluted hydrocarbons were isolated by bubbling the effluent helium carrier gas which contained them through spectroscopic grade cyclohexane. Their ultra-violet absorption spectra were then recorded.

Fig. 2 represents a plot of the sum of the concentrations of the principal polycyclic aromatic hydrocarbons found in the soot, namely (anthracene + phenanthrene), methyl phenanthrenes, fluoranthene, pyrene, methyl pyrenes, 2,13-benzfluoranthene, (chrysene + 1,2-benzanthracene) versus height above the burner, for flames 1 and 2. This corresponds to acetylene/oxygen ratios of 1·2 and 1·5 respectively.

The concentrations of a number of polycyclic aromatic hydrocarbons in the soot relative to that of pyrene are plotted against height above the burner for flame 1 in Fig. 3.

Bonne, Homann and Wagner[1,2], who investigated a similar flame to that used in the present work, found that