suggested that they represent upper limits to the observable lifetimes in materials of high purity and crystal perfection.[37,38] Dumke[39] has pointed out, however, that because of successive reabsorptions of photons emitted in the direct recombination process, the maximum effective lifetimes of electrons and holes in perfect crystals may be considerably longer than the radiative lifetimes. This reabsorption mechanism is expected to be particularly important in materials like InAs which have large absorption coefficients near the absorption edge. Second, the experimental values of

the carrier lifetimes in InAs which have been reported were determined using the photoelectromagnetic-photo-conductive ratio method.[40] They have been both larger and smaller than corresponding values of the calculated radiative lifetimes. However, experimental lifetimes determined in this way are not always equal to the lifetimes of the carriers when carrier trapping is involved.[41] Since the significance of trapping in InAs has not been studied, the carrier lifetimes which have been reported must be considered uncertain.

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Critical Percolation Probabilities (Bond Problem)

V. A. VYSSOTSKY, S. B. GORDON, AND H. L. FRISCH
Bell Telephone Laboratories, Murray Hill, New Jersey

AND

J. M. HAMMERSLEY
University of Oxford, Oxford, England

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Monte Carlo estimates of the critical percolation probabilities for the "bond problem" are presented for a number of two- and three-dimensional lattices. The agreement between the Monte Carlo estimates and the estimates obtained by Domb and Sykes obtained from series expansion for the mean cluster size are quite satisfactory.

TWO simple percolation problems[1] of physical interest arise when "particles" are distributed at random over an infinite regular space lattice in two or three dimensions: In the "site problem" a "particle" occupies a "vertex" of the space lattice (and in the "bond problem" a "bond" connecting two "vertices") independently of all others with fixed probability p. The site problem arises, e.g., in models of random binary alloys or a dilute ferromagnetic crystal[2-5] while the bond problem arises, e.g., in a simple model of single-phase dispersive flow of a fluid (i.e., the percolation of a fluid into and through a "random maze"[1,5]). When p is less than the critical probability p_c, then there is zero probability that a given site or bond is occupied by a "particle" which is a member of an infinite set of "particles" linked to one another through adjoining bonds and sites (cluster). (For the random ferromagnet p_c is simply related to the critical susceptibility at

$0°K$ while for the percolation of a fluid through a "random maze" the expected fraction of "wetted" vertices is finite for $p > p_c$.)

Using a Monte Carlo method, adapted for an IBM 7090 computer to be described elsewhere,[6] we have numerically estimated the critical probabilities for the bond problem for a number of two- and three-dimensional crystal lattices. In Table I, we present the mean critical probabilities in 100 runs in which finally 2000 vertices are "wetted" (average machine computation time per run is about seven seconds). The agreement between the Monte Carlo estimates of p_c and the estimates, $p_c^{D.S.}$, obtained from series expansions for the mean cluster size[2,7] are quite satisfactory.

The value of p_c shown in Table I is the sample mean for those runs in which a higher p was required to "wet" 2000 vertices than to "wet" 100 vertices. This criterion is intended to reduce the systematic positive bias on p_c introduced by local irregularities at the beginning of the simulated flow. The remaining biases are believed

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TABLE I. Bond critical probabilities (with d the number of dimensions and z the coordination number of the lattice).

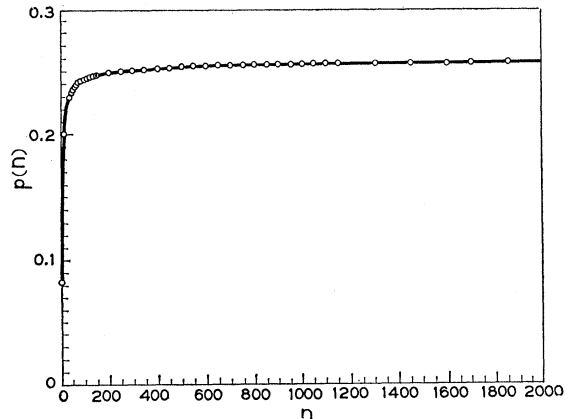| Lattice	d	z	p_c	Standard deviation in p_c	$p_c^{D.S.}$	$2/z$	$zp_c/2$
Triangular	2	6	0.341	0.011	0.33	0.33	1.03
Square	2	4	0.493	0.013	0.50	0.50	0.99
Hexagonal	2	3	0.640	0.018	0.66	0.67	0.96
Hexagonal close-packed	3	12	0.124	0.005	···	0.17	0.73
Face-centered cubic	3	12	0.125	0.005	···	0.17	0.74
Simple cubic	3	6	0.254	0.013	0.24	0.33	0.77
Tetrahedral	3	4	0.390	0.011	···	0.50	0.78
Ice (quartz)	3	4	0.388	0.010	···	0.50	0.78

FIG. 1. Plot of $p(n)$ vs n for the simple cubic lattice. Other lattice structures give a curve analogous to this.

to be comparable to the standard deviation; efforts to evaluate these bias effects more precisely are under way. It is known[5] that the sum of p_c for the two-dimensional triangular and hexagonal lattices cannot be less than one. Hence the mean value of p_c for the triangular or hexagonal lattice is too low; although this condition is satisfied within the indicated deviations. For the square lattice it is known that $p_c \geq \frac{1}{2}$.[8]

p_c appears to be little affected by differences of lattice type if the number of dimensions and coordination number are the same. Although it appears that for these lattices within the indicated deviations zp_c is only a function of d [say $zp_c = d/(d-1)$], a known counter-

example in two dimensions shows that this is not true in general.[9]

If $p(n)$ represents the expected probability of bond occupation at which n vertices have been "wetted," then $p(n)$ appears to approach p_c exponentially with n as shown in Fig. 1. An analogous program for numerically investigating the critical probabilities for the site problem is nearing completion and we expect that numerical results will be available shortly.

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[9] E. N. Gilbert (private communication).

Superconductivity of Technetium Alloys and Compounds

V. B. Compton, E. Corenzwit, J. P. Maita, B. T. Matthias, and F. J. Morin
Bell Telephone Laboratories, Murray Hill, New Jersey
(Received April 25, 1961)

The superconducting transition temperatures of Mo-Tc alloys are reported. Critical field measurements of a 50 atomic percent alloy indicate that it might be a promising material for superconducting magnets. The similarity of Tc and Re with respect to alloy and intermetallic compound formation is noted. The superconducting transition temperatures of the compounds ZrTc$_6$ and NbTc$_3$ are 9.7°K and 10.5°K, respectively. X-ray diffraction data suggest that these compounds have the α-Mn type structure.

THE recent increase in the availability of technetium metal prompted an investigation of the superconducting properties of Mo-Tc alloys and of the compounds ZrTc$_6$ and NbTc$_3$. No alloys or intermetallic compounds of technetium have been reported previously in the literature.

I. Mo-Tc ALLOYS

The superconducting transition temperature of technetium has been reported by Daunt and Cobble[1] as 11.2°K for powder of $\geq 99.9\%$ purity. The transition had a range from about 8° to 11°K, which was attributed to the geometrical shape of the specimen.

Hulm[2] has reported the superconducting behavior of Mo-Re alloys. He found that the transition temperature approaches 12.5°K for the intermediate range of the solid solution of Re in Mo.

On the basis of the results of these two investigations, it was decided to study superconductivity in the Mo-Tc system assuming that Tc and Re have similar alloying behavior. The Tc metal as received was in the form of chips coated with an oxide layer. Since the melting point of Tc is close to 2200°C, the melts were prepared in an arc furnace in an argon atmosphere. Prior to melting, the Tc lost about 20% of its weight during heating in the furnace. The weight loss of the melted

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