Experiments using 0.1 percent argon in neon were also carried out. These experiments gave identical results to the helium-argon studies, again showing the absence of large recombination under conditions in which molecular ions are absent.

Following the initial report of the large recombination coefficients, a variety of processes were considered as possible recombination mechanisms. For example, in addition to the previously mentioned radiative capture and dissociative capture of electrons by molecular ions, three-body processes involving two electrons and an ion, various plasma effects (e.g., cut-off of coulomb potential in an ionized medium), and negative ion formation in noble gases were all considered in an effort to find the source of the large recombination. These considerations, which were necessitated by the difficulty in finding an electron capture mechanism efficient enough to yield the observed recombination coefficients, may now be discarded. All available evidence indicates that the recombination is a two-body process involving an electron and a molecular ion and that the mechanism is probably dissociative recombination.

The author is greatly indebted to T. Holstein for suggesting these admixture experiments as a conclusive demonstration of the role of molecular ions in the observed recombination.

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Measurement of the Elastic Constants of Silicon Single Crystals and Their Thermal Coefficients

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INTEREST in the properties of silicon single crystals arising from their use as semiconductors has led us to make measurements of the elastic constants of two single crystals. Measurements of velocities of propagation for both shear and longitudinal waves were made in the crystals as described in a recent paper by McSkimin.[1] Frequencies in the range 8–12 Mc/sec were used.

The three independent elastic constants were evaluated, a density of 2.331 (measured by pycrometer) being used. Data and formulas used are summarized in Table I. Two crystals were measured—as indicated—with data obtained from the larger one being used to determine the elastic constants. Check measurements were made for the smaller crystal; and despite the less accurate "pulse overlap" technique used for two of the measurements, velocity agreement to within 0.15 percent was obtained.

Both crystals were of a high degree of crystalline perfection as shown by etching and x-ray tests.

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Table I. Data for silicon single crystals ($\rho=2.331$; $\alpha=7.63\times10^{-6}$).

Direction of propagation	Direction of particle motion	Type of mode	Equation for velocity	Velocity at 25°C in cm/sec	Velocity temp. coeff.
			(Crystal 1)		
110 $l=9.0140$ mm	$1\bar{1}0$	Shear	$V_1=\left(\frac{0.5C_{11}-0.5C_{12}}{\rho}\right)^{\frac{1}{2}}$	4.682×10^5	—
001 $l=5.9746$ mm	110	Shear	$V_2=(C_{44}/\rho)^{\frac{1}{2}}$	5.843×10^5	-16.3×10^{-6}
001	001	Long.	$V_3=(C_{11}/\rho)^{\frac{1}{2}}$	8.474×10^5	-26.2×10^{-6}
110	110	Long.	$V_4=\left(\frac{0.5C_{11}+0.5C_{12}+C_{44}}{\rho}\right)$	9.167×10^5 (calculated)	—
			(Check crystal 2)		
110 $l=3.2215$ mm	$1\bar{1}0$	Shear	V_1	4.682×10^5	-42.3×10^{-6}
110	001	Shear	V_2	5.834×10^5 (29°)	—
110	110	Long.	V_4	9.152×10^5 (30°)	—

Elastic constants (25°C)
$C_{11}=1.6740\times10^{12}$ dynes/cm²
$C_{12}=0.6523\times10^{12}$
$C_{44}=0.7957\times10^{12}$

Elasticity-temp. coeff.
$K_{C_{11}}=-75.3\times10^{-6}$ parts per °C
$K_{C_{12}}=-24.5\times10^{-6}$
$K_{C_{44}}=-55.5\times10^{-6}$

Uncertainties for crystal 1
l—0.02%; freq.—0.01%; elastic constants—0.26%; ρ—0.10%; velocities—0.08%