

FIG. 8. Equivalent ring source for the $(n - 1)$ th reflected rays.

An equivalent ring source having a radius $a_e = |x_c^\pm|$ and located at $z = 2L_e$, representative of the virtual caustic for the multiply reflected rays, may be employed as in (79) to generate

the multiply reflected ray field amplitude as the observation point approaches the resonator axis. Near the axis, a caustic is formed because of the convergence of rays from various portions of the virtual ring source. To correct the ray optical field, we proceed as in (84) and write

$$A_n^\pm(x) = \frac{J_m(Y_n) \mp iJ_{m+1}(Y_n)}{\exp(\mp iY_n)}, \quad (98)$$

where

$$Y_n = \frac{k\rho a_e}{2L_e} = \frac{ka^2|C_n^\pm|}{2L} |x| = \frac{4\pi N_{eq}}{1 - M^{-2n}} \frac{|x|}{M^n}. \quad (99)$$

This result is used in (22); the large argument asymptotic form of (99) yields the ray field in (19).

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Temperature variation of total hemispherical emissivity of stainless steel AISI 304

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Numerical values of the total hemispherical emissivities ϵ_h of a mechanically polished surface and an electropolished surface of a sample of stainless steel, type AISI 304, have been determined experimentally for the first time in the temperature range 340-1100 K. An absolute method incorporating the transient calorimetric principle was used in these measurements. It is found that the ϵ_h values obtained are only very slightly different from those predicted by a classical expression for total hemispherical emissivity developed by Davisson and Weeks.

INTRODUCTION

According to a classical theory of thermal emission developed by Davisson and Weeks¹ and believed until recently to hold good for good conductors above room temperature, the total hemispherical emissivity ϵ_h is given by

$$\epsilon_h = 0.754(\rho T)^{1/2} - 0.632(\rho T) + 0.670(\rho T)^{3/2} - 0.607(\rho T)^2, \quad (1)$$

where ρ is the electrical resistivity of the conductor in Ω -cm and the temperature T is in Kelvin. This expression was claimed to be accurate to better than 1% when $\rho T < 0.1 \Omega$ -Cm K, a condition satisfied by most pure metals and several alloys up to 1000 K. Recent studies²⁻⁵ of the temperature variation of ϵ_h of copper, aluminum, silver, and tungsten in the range 160-1000 K, carried out with a transient calorimetric technique developed in this Department have, however, shown the existence of large departures of the experimental ϵ_h vs T

curves from Eq. (1). For all four metals the experimental curves are significantly lower than those predicted by Eq. (1). The measured values of ϵ_h are in extreme cases, only 50% of the theoretical values. These departures have been found to be attributable to the nonzero values of the relaxation times τ , of the conduction electrons which were tacitly assumed to be zero in the Davisson and Weeks theory.

A more recent theory developed by Parker and Abbott⁶ takes into account the effect of the finite, nonzero values of τ on the surface currents which are known to be responsible for reflection and absorption of electromagnetic waves by metals in any theory based on the premises of classical electrodynamics. For convenience we reproduce here a generalized form of the Parker and Abbott expression for the total hemispherical emissivity,

$$\epsilon_h = k_1(\rho T)^{1/2} - [k_2 - k_3 \ln(\rho T)] \rho T + k_4(\rho T)^{3/2}, \quad (2)$$

TABLE I. Values of the four k parameters of Eq. (2) for various values of the relaxation parameter $a = 1.31 \times 10^{11} \tau T$, in the range 0 to 1.5.

Relaxation parameter a	k parameters defined by Eq. (2)			
	k_1	k_2	k_3	k_4
0.00	0.766	0.309	0.0889	-0.0175
0.06	0.693	0.280	0.0678	-0.0050
0.12	0.618	0.252	0.0521	+0.0052
0.18	0.554	0.225	0.0432	+0.0122
0.24	0.501	0.208	0.0377	+0.0173
0.30	0.462	0.196	0.0328	+0.0209
0.36	0.431	0.187	0.0285	0.0242
0.42	0.408	0.179	0.0249	0.0270
0.48	0.389	0.174	0.0217	0.0295
0.54	0.373	0.169	0.0193	0.0320
0.60	0.359	0.166	0.0175	0.0341
0.66	0.346	0.162	0.0159	0.0363
0.72	0.334	0.160	0.0146	0.0381
0.78	0.322	0.158	0.0137	0.0400
0.84	0.310	0.1561	0.0126	0.0417
0.90	0.300	0.155	0.0119	0.0434
0.96	0.288	0.153	0.0112	0.0450
1.02	0.278	0.152	0.0105	0.0468
1.08	0.269	0.151	0.0101	0.0484
1.14	0.260	0.151	0.0096	0.0498
1.20	0.252	0.150	0.0091	0.0513
1.26	0.246	0.149	0.0088	0.0526
1.32	0.241	0.149	0.0084	0.0539
1.38	0.237	0.149	0.0080	0.0550
1.44	0.234	0.148	0.0078	0.0560
1.50	0.232	0.148	0.0076	0.0570

in which $k_1, k_2, k_3,$ and k_4 are parameters whose values are determined by the numerical values of a relaxation parameter $a = 1.31 \times 10^{11} \tau T$. The values of $k_1, k_2, k_3,$ and k_4 for various a values in the range 0 to 1.5 of practical interest, obtained by graphical interpolation from the data given by Parker and Abbott, are given in Table I. It is needless to state that the value of $k_1 = 0.766$ for the limiting case of $a = 0$ and $\tau = 0$ is very nearly the same as the numerical coefficient 0.754 of the most important first term involving $(\rho T)^{1/2}$ in Eq. (1). By determining the set of k values that gives the best fit of Eq. (2) with the experimental data over any given temperature range, it is possible to estimate the emissive relaxation time τ_e of conduction electrons in the material. Such estimates of τ_e , made for copper, aluminum, silver, and tungsten, are found to be smaller but generally of the same order of magnitude as the electrical relaxation times τ_c , estimated from dc conductivity data. A discrepancy of this nature may be expected if we recognize the fact that the Parker and Abbott theory does not take into account the effect of the intrinsic surface scattering of the conduction electrons in the metal which would reduce the emissive relaxation times below their bulk values. Yet another possible reason for this discrepancy is the well-known fact that between surface preparation and ϵ_h measurement even the most carefully prepared surfaces get oxidized and also contaminated with foreign atoms to varying extents depending on the conditions of handling. Such deterioration will also, in effect, reduce the relaxation times calculated from ϵ_h vs T data below the bulk relaxation times deducible from dc conductivity data.

Recently, Sievers⁷ has used the classical free-electron model of Drude and developed an expression for ϵ_h which takes into

account the effect of diffuse scattering of conduction electrons at the surface of the metal. He has shown that the recent data on Cu and Al referred to earlier² agree within the accuracies of measurement, with the corresponding ϵ_h vs T curves deducible from his equation.

The discrepancy observed between the τ_c values and the τ_e values of Cu, Al, and Ag referred to earlier does not by itself invalidate the Parker and Abbott treatment of the contribution of the bulk metal to thermal emission. Better agreement between the two τ -values may perhaps be observed if allowance is made, as has been done by Sievers, for the contribution to ϵ_h due to surface scattering. Regardless of whether or not Eq. (2), after suitable modification to account for surface scattering, adequately represents thermal emission by good conductors for which $\omega\tau > 1$ (the angular frequency here refers to the mean frequency of thermal emission and is given by $\omega \sim k_B T/\hbar$), there seems to be little doubt about its validity in the continuum limit of $a = 0$ at which $\omega\tau \rightarrow 0$.

As mentioned before, measurements carried out in this Department on Cu, Al, Ag, W, and Mo⁸ have clearly demonstrated that the zero- τ approximation results do not hold good for these metals and perhaps also for other pure metals that are good conductors as well. But the situation is quite different with regard to alloys in which the mean free paths λ , and consequently the relaxation times τ , are limited not only by the thermal scattering mechanisms but also by the presence of impurity atoms around which strains are produced. In a highly disordered alloy this additional scattering is so important that λ may, in extreme cases, be reduced to a few atomic diameters. With a Fermi velocity of the order of 10^8 cm/s, τ could be as short as 10^{-15} s. For thermal radiation at 700 K this gives for $\omega\tau$, a value of 0.1 which is considerably less than 1. A highly disordered alloy may, therefore, be expected to approximate closely a continuum in regard to thermal emission and thus obey Eq. (2) for $a = 0$ and also Eq. (1). A need to verify this prediction prompted the present research on the temperature dependence of ϵ_h of stainless steel AISI 304 referred to hereafter as SS 304.

This material was chosen for this work for several reasons. First, it is nonferromagnetic. Secondly, it is very easily polished, both mechanically and electrolytically. Further, stainless steel does not oxidize easily inside a vacuum even at moderately high temperatures, $T \sim 1000$ K. Moreover, emissivity measurements on stainless steel were considered to be of practical interest and importance because of the widespread applications of this material.

I. EXPERIMENTAL TECHNIQUE AND ACCURACY OF MEASUREMENT

The transient calorimetric principle used for measuring ϵ_h in this work, has been described in previous publications and will not be repeated here. By this technique the experimental emissivity of a specimen of mass M , and of surface area A , cooling inside a vacuum by spontaneous radiation may, without appreciable loss of accuracy,⁹ be calculated from the equation

$$-MC_p dT/dt = \epsilon_h \sigma A (T^4 - T_0^4) + \dot{Q}_t + \dot{Q}_g, \quad (3)$$

where C_p , dT/dt , and σ are, respectively, the specific heat of the specimen at constant pressure, the cooling rate of the

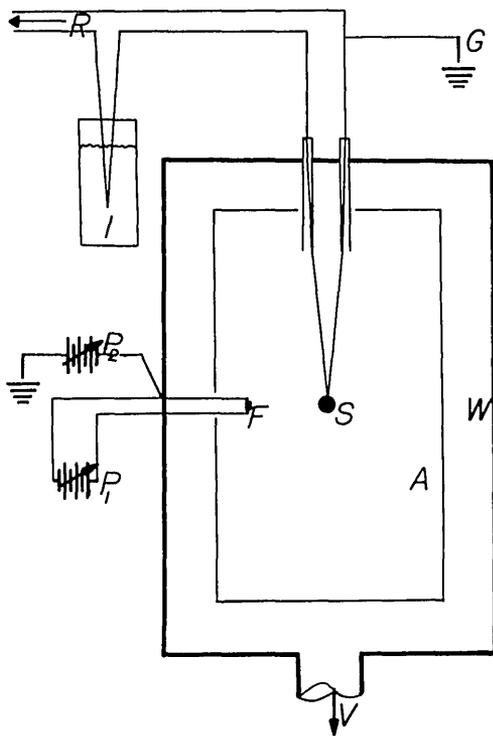


FIG. 1. Schematic drawing of the electron gun apparatus: S, specimen; W, stainless steel vacuum chamber; F, tungsten filament; P_1 , filament power supply; P_2 , electron beam power supply; I, compensating thermojunction at 0°C ; R, Leeds & Northrup Speedomax recorder; A, Electrostatic shield of 0.25-cm thick aluminum; V, cold trap and pumping unit.

specimen at temperature T , and the Stefan-Boltzmann constant. \dot{Q}_t and \dot{Q}_R are small correction terms for the power losses through the thermocouple wires attached to the specimen and through the residual gas surrounding it.

In this research measurements were carried out using two separate experimental arrangements, both incorporating the transient calorimetric principle. The first was the same as that described by Zuppardo and Ramanathan¹⁰ in which the heating of the specimen was achieved with an rf coil. In the second arrangement, the essentials of which are shown in Fig. 1, the heating of the specimen suspended inside a large stainless steel vacuum chamber, is achieved by an electron gun, also mounted inside the chamber. The spherical specimen, which was the same throughout this investigation, was held at ground potential while the filament of the electron gun was maintained at a negative potential of approximately 1200 V with respect to ground. It was necessary to ground the specimen because a recorder, connected to it by the thermocouple wires, had to be grounded during experiments for safety reasons. With this arrangement the specimen could be heated up to 1100 K in approximately 15 min. The temperature rise of the chamber walls during this process was of the order of 0.5 K. This was estimated to cause only a negligible error of 0.06%.

Both mechanically polished and electrolytically polished surfaces of the specimen were used in these measurements. Mechanical polishing was accomplished by first buffing the machined surface of the specimen with 600-grade silicon carbide paper. Then, a cloth soaked in Brasso was used to smooth out the small scratches. Electropolishing was per-

formed by using a method given for stainless steels by Tegart.¹¹ It was found, however, that the current density recommended by Tegart had to be increased in order to produce the best result.

After polishing, the specimen was rinsed thoroughly in warm water for several minutes, then in generous quantities of double-distilled water. Mechanically polished surfaces were, however, first washed with acetone to remove all traces of Brasso before subjecting them to the above treatment. The polished specimen was mounted inside either of the two apparatuses by suspending it from a spot-welded thermocouple junction consisting of 0.0127-cm diameter chromel and alumel wires. This was accomplished by inserting the junction inside a 0.08-cm diameter hole drilled into the specimen, and fixing it in place with a small copper pin. A copper pin was preferred to one of stainless steel because of its softness and of its greater coefficient of expansion. These result in a frictional fit that improves with increasing temperature. The emissive effects of the pin are negligible. The mass of the spherical specimen¹² decreased from an initial value of 7.7930 g for run No. 1 with a mechanically polished surface to a final value of 6.6991 g for run No. 6 with an electropolished surface, both runs being made with the rf coil apparatus. The surface areas during these two runs were 5.1198 and 4.5988 cm^2 , respectively.

After a run was completed, the temperature decay curve was plotted using the emf-versus-time data obtained with the recorder. The decay curve-obtained on run No. 6 with the electropolished specimen is shown in Fig. 2. From this curve a set of dT/dt vs T data is obtained for use in Eq. (3). The C_p data, which are also required in Eq. (3), are those obtained from the published work of Liusternik.^{13,14} These were preferred to the data of Venturi and Seibel¹⁵ because the latter are believed to be systematically in error by about 25%. A comparison of Venturi and Seibel's published results for several different materials with the results of other investigators for the same materials showed that *all these data* of Venturi and Seibel are 25% less than the corresponding data of other investigators. Moreover, a specific heat measurement carried out by us with a simple technique on our SS 304 sample at room temperature (299 K), gave a result that agreed very closely with Liusternik's value for that temperature. Our measurement of C_p was not extended to higher temperatures

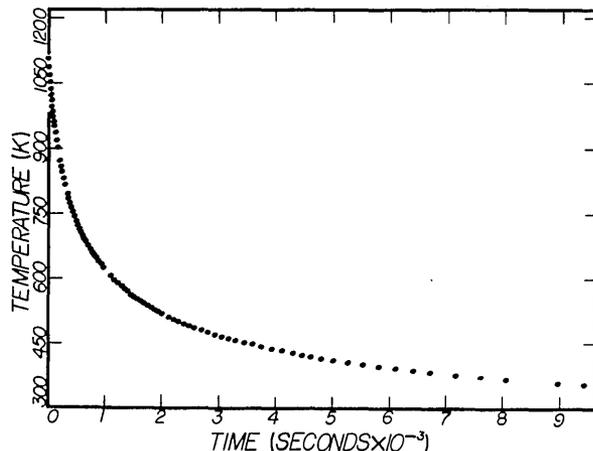


FIG. 2. Temperature versus time plots for the electropolished surface, run No. 6.

TABLE II. Electrical resistivities, specific heats and total hemispherical emissivities of SS 304 at various temperatures.

Temp (K)	ρ $\Omega\text{-Cm}$	C_p^a (cal/gK)	ϵ_h (%)			
			Experimental		Theoretical	
			rf coil ^b runs 1 and 6	e gun run 2	Eq. (1)	Eq. (2) $\alpha = 0.024$
340	77.41	0.1154	10.43	10.19	10.76	10.40
380	80.47	0.1177	11.10	11.15	11.50	11.12
420	83.53	0.1199	11.77	11.99	12.21	11.81
460	86.59	0.1220	12.39	12.72	12.91	12.49
500	89.66	0.1240	13.02	13.34	13.58	13.14
540	92.72	0.1259	13.59	13.85	14.24	13.79
580	95.54	0.1277	14.16	14.17	14.86	14.40
620	98.00	0.1295	14.69	14.47	15.45	14.98
660	100.25	0.1312	15.21	14.76	16.01	15.53
700	102.30	0.1327	15.71	15.06	16.54	16.05
740	104.14	0.1342	16.17	15.55	17.05	16.55
780	105.78	0.1356	16.65	16.34	17.53	17.03
820	107.21	0.1370	17.09	17.28	17.99	17.49
860	108.44	0.1382	17.56	18.40	18.42	17.92
900	109.45	0.1393	17.91	19.68	18.83	18.33
940	110.27	0.1404	18.29	21.12	19.21	18.71
980	110.87	0.1414	18.66	22.74	19.57	19.08
1020	111.27	0.1422	19.00	24.51	19.91	19.42
1060	111.47	0.1430	19.32	26.46	20.22	19.74
1100	111.46	0.1438	19.63	28.56	20.51	20.04

^a Smoothed-out specific heat data of Liusternik.

^b Our best emissivity values for SS 304 obtained with the rf coil apparatus.

because of the inadequacy of our technique. Additional justification for using Liusternik's C_p data in Eq. (3) is given below.

Well above the Debye characteristic temperature, the specific heats of different samples of a pure metal are known to differ only to a negligible extent due to slight variations in composition of the order of 100 ppm. An examination of C_p data in published literature,^{16,17} shows that the same is generally true for alloys like SS 304, in which the main constituents do not differ much in regard to density and atomic weight. This is a consequence of the Dulong and Petit law that makes the high-temperature atomic heat a nearly constant quantity. The literature study also shows that the density of stainless steel is not significantly altered by variations of as much as a percent or two in the composition of the main constituents. As a consequence the high-temperature specific heats also remain insensitive to variations in composition of this order.

The ρ vs T data required to determine the theoretical ϵ_h vs T curves from Eqs. (1) and (2) were obtained from actual measurements made on a specimen of SS 304 cut from the same source as was the emissivity specimen. The resistivity specimen was in the form of a cylindrical rod of length 6 cm and diameter 0.201 cm. In addition to fixing the necessary current and potential leads required on this specimen to facilitate resistivity measurements by a potentiometric technique, a chromel-alumel thermocouple was also spot-welded to the midpoint of the rod in order to determine its temperature. Measurements at different temperatures were carried out by heating the specimen inside a Marshall furnace. The ρ vs T data thus obtained are reproduced in Table II.

The method of evaluating the correction term \dot{Q}_i has been

described by Estalote and Ramanathan and hence will not be repeated here. Using this method it is found that the resulting error in ϵ_h is only 0.08%. The gas pressure inside the vacuum chamber of the rf coil apparatus was not allowed to rise above 5×10^{-6} Torr. Thus the value of \dot{Q}_g , which was of the order of 0.05% of the radiative power loss \dot{Q}_r , was found to be negligible. The error in ϵ_h caused by neglecting the power reabsorbed by the specimen after reflections from the inside wall of the evacuated enclosure can also be shown² to be negligible.

In Eq. (3) the temperature of the cooling specimen is, at any instant of time, assumed to be the same everywhere inside. However, for any material of finite thermal conductivity, the temperature at the geometric center is higher than the temperature at the surface. The method of evaluating this difference of temperature ΔT , based on the Fourier equation for heat conduction, has been discussed in an earlier paper.² Using this method it is found that for our sphere of SS 304, ΔT is of the order of 0.005 K at 340 K and 0.9 K at 1100 K. This nonuniformity of specimen temperature results in an error in ϵ_h of 0.001% at 340 K and 0.08% at 1100 K.

The specimen mass could be measured to an accuracy of 0.1 mg; this leads to a negligible error in ϵ_h of less than 0.005%. The diameter of the specimen¹² which was 1.2766 cm during run No. 1 and 1.2099 cm during run No. 6, was measured at room temperature to an accuracy of 0.0005 cm. Since a thermal expansion correction was applied while determining the areas at various temperatures, the inaccuracy in A is believed to produce an error in ϵ_h of less than 0.005%.

In Eq. (3) the only major contributors to the uncertainty in ϵ_h are the quantities C_p , dT/dt and the nonuniformity of the specimen temperature ΔT . The uncertainty in the C_p

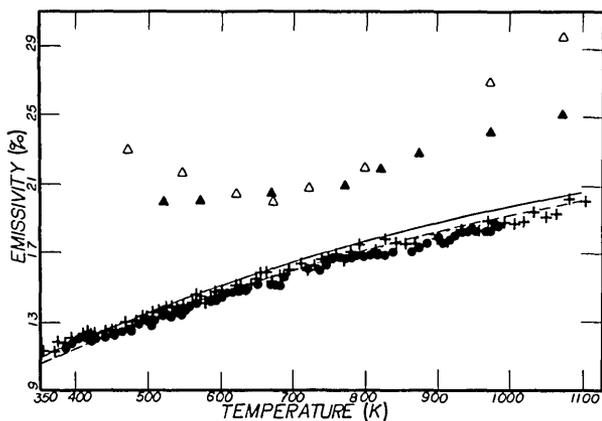


FIG. 3. ϵ_h vs T data for stainless steel: +, present work on mechanically polished SS 304; ●, present work on electropolished SS 304; ▲, data of Richmond and Harrison on SS 321; △, data of Richmond and Harrison on SS 430; —, Eq. (1) of Davison and Weeks; - - - - - , Eq. (2) of Parker and Abbott for $a = 0.024$.

vs- T data is believed to be approximately 1%. The cooling rates dT/dt , which were determined to the nearest 0.01 K/s, give rise to an error in ϵ_h of slightly over 0.5%. The emf-vs- T data for the chromel-alumel pair, provided by the manufacturer, could be in error by two to three degrees at temperatures far away from the calibration points. This results in an error in ϵ_h of the order of 1%. Combining all these significant errors, it is believed that the ϵ_h values determined by the two different techniques could be in error by not more than 3%.

II. RESULTS AND DISCUSSION

Figure 3 contains the plots of the ϵ_h -vs- T data for two separate runs made with the rf coil apparatus; run No. 1 with a mechanically polished surface and run No. 6 with an electropolished surface. As can be seen the two sets coincide almost indistinguishably from each other. From the figure and from column four of Table II, it is seen that the numerical ϵ_h values increase steadily from 10.4% at 340 K to 19.6% at 1100 K.

A thorough survey of available literature showed that the only existing experimental emissivity data for SS 304 had been obtained with an oxidized specimen,¹⁸ and hence is of no use for comparison with present results. However, because of the similarities of the compositions of the different types of stainless steels (see Table III), it is appropriate to reproduce in Fig. 3 the emissivity data of Richmond and Harrison¹⁹ for an electropolished sample of SS 321 and for a mechanically

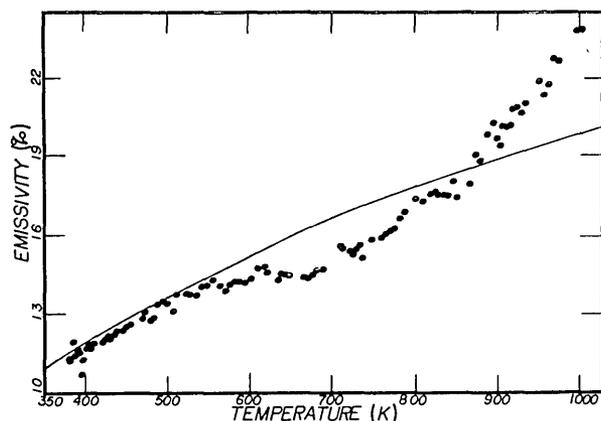


FIG. 4. ϵ_h vs T data for SS 304: ●, present work on mechanically polished surface with electron gun technique, run No. 2; —, Eq. (1) of Davison and Weeks.

polished specimen of SS 430. Although the compositions of all three alloys are similar, it is seen that the ϵ_h -vs- T data obtained by Richmond and Harrison lie well above our data for SS 304. Unfortunately, Richmond and Harrison did not give ρ -vs- T data for their samples of SS 321 and SS 430. Therefore, it is not possible to determine whether or not their data showed agreement with the classical zero-relaxation theory. Furthermore, this makes it difficult to make any relevant comparison of their data with the present data for SS 304.

Also included in Fig. 3 is the theoretical ϵ_h -vs- T curve for SS 304 deduced from Eq. (1) using the resistivity data given in Table II. As mentioned before, this equation was developed on the assumption that $\rho T < 0.1 \Omega \text{ cm K}$. This criterion is satisfied by SS 304 for temperatures up to 940 K. It is seen that the experimental ϵ_h -vs- T data for SS 304 fall only slightly below the theoretical curve. The actual experimental emissivity values are about the same as the theoretical values at 340 K but are about 4% lower around 1100 K. The last-mentioned percentage difference is only slightly greater than the uncertainty of the present measurements.

A typical set of ϵ_h -vs- T data obtained during run No. 2, with the electron-gun apparatus and a mechanically polished surface, is reproduced in Fig. 4. From this figure and from columns four and five of Table II, it is seen that in the temperature range 350 to 750 K, the ϵ_h -values of this run are nearly the same as those plotted in Fig. 3 for runs 1 and 6 made on the rf coil apparatus. However, the rapid increase in the "e gun" emissivity values above 750 K, represents a departure

TABLE III. Percentage compositions (nominal) of different types of stainless steels.

Trade name	Constituent elements (%) ^a								
	C	Mn	Si	P	S	Cr	Ni	Ti	Fe
AISI 304	0.08	2	1	0.04	0.03	18	8	—	Balance
AISI 321	0.08	2	1	0.04	0.03	17	9	Traces	Balance
AISI 430 ^b	0.12	1	1	0.04	0.03	14	—	—	Ferritic base
Steel Kh18N9T	0.12	2	0.8	0.035	0.03	17-20	8-11	0.8	Balance
Steel mark 1 × 18 N9T	0.12	2	0.8	0.035	0.03	17-20	8-11	0.8	Balance

^a Percentages given are upper limits except where ranges are specified.

^b AISI 430 (SS 430) is ferromagnetic.

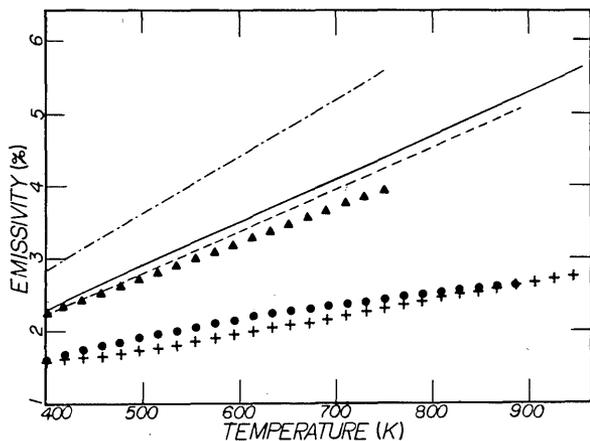


FIG. 5. ϵ_h vs T data for copper, aluminum, and silver²: +, electropolished copper; —, Eq. (1) for copper; ▲, electropolished aluminum; - - - -, Eq. (1) for aluminum; ●, chemically polished silver; - - - - -, Eq. (1) for silver.

from the rf coil data, which well exceeds the uncertainty of present measurements. While it is satisfying to find that the two different techniques used in this research produced nearly the same values over much of the temperature range investigated, it is necessary to seek an explanation for the large discrepancy observed above 750 K. A microscopic examination of the electron-gun heated specimen revealed widespread pitting of the surface which was not present before electron bombardment. Therefore it is believed that this surface damage, obviously due to electron bombardment, was responsible for the increased ϵ_h values above 750 K.

An increase in ϵ_h due to the creation of small pits may be expected since these would tend to behave like black-body cavities rather than as a smooth alloy surface. However, in order to account for the observed e -gun data over the entire range of 340 to 1100 K, it is necessary to invoke also other possible effects of electron bombardment of the surface. For example, the carbon atoms in stainless steels are known to "precipitate" or redistribute themselves during such processes as welding. Presumably such redistribution occurred also during electron bombardment of our specimen of SS 304.

Since the rf coil has been found to be more satisfactory than the e gun for heating the specimen, we shall use only the experimental results obtained with the former technique in the following discussions involving comparisons with theoretical predictions.

In order to compare and contrast the behavior of this alloy (SS 304) with those of pure metals in regard to the behavior of the ϵ_h -vs- T curves, we reproduce in Fig. 5, the ϵ_h -vs- T data of Cu, Al, and Ag obtained by Ramanathan and Yen along with the corresponding theoretical curves obtained with Eq. (1). It is obvious that the numerical ϵ_h values of SS 304 shown in Fig. 3 and column four of Table II are considerably higher than those of the pure metals. However, the ϵ_h vs T curves of all four materials are below the corresponding zero-relaxation theoretical curves obtained with Eq. (1). It is also obvious that the departure is very large for the pure metals but only slight, if any, for SS 304. This result was indeed expected by considering the much shorter relaxation times for the alloy at any temperature. The difference between the theoretical and experimental curves of SS 304, seen in Fig. 3, is only just outside the estimated uncertainty of our measurements.

Thus, it is possible either to ignore this slight discrepancy and conclude that a disordered alloy obeys the classical zero-relaxation result of Eqs. (1) and (2), or to attach significance to this rather dubious departure and apply to the experimental data Eq. (2) which neglects surface scattering effects.

Thus an attempt to fit the experimental data to a curve obtained from Eq. (2) was undertaken and the set of k parameters that gave the best fit with the measured data of Table II, was found to be the one for which $a = 0.024$. This fitted curve, which is also shown in Fig. 3, may be seen to agree well with our best experimental data, within the uncertainty of measurements. The numerical value of the a parameter corresponds to a relaxation time of $\tau_e = 2.3 \times 10^{-16}$ s at a temperature of 800 K. An estimate of τ_e has also been made from the resistivity equation $\rho = m/ne^2\tau$, where e is the electronic charge and m and n are respectively the effective mass and the number density of conduction electrons in SS 304. Using the free-electron mass for m and a value of n determined by the rules of valency (valency number assumed for SS 304 = 3) and a value of $\rho = 106.52 \mu\Omega$ cm corresponding to a temperature of 800 K, it is found that τ_e is 1.5×10^{-16} s. This is so close to τ_e that one is tempted to conclude that a slight relaxation effect is indeed observable in SS 304. It is desirable, however, to carry out spectral emissivity measurements on SS 304 and also spectral and total emissivity measurements on other alloys before we can generalize the conclusion we have reached here.

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