MECHANISM OF ANODIC SOLUTION OF HOMOGENEOUS AND HETEROGENEOUS METALLIC MATERIALS

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It is shown that heterogeneity of metal surfaces is not a necessary condition of initiation and development of electrochemical corrosion, but can have a marked influence on the corrosion process, which, considering the possible influence of inhomogeneities of the metal surface, is nevertheless always represented by the laws of electrochemical kinetics. A number of examples of this influence are analyzed theoretically: i) shift in the corrosion potential of a metal toward the positive (with constant overvoltage of anodic solution) as a result of deposition of small amounts of noble metal on the surface, accompanied either by acceleration (active solution) or retardation (passivation) of the corrosion process; ii) self-passivation resulting from preferential solution of the main phase and enrichment of the surface with secondary phases or initiation of solution of the former owing to enhanced solution of the latter; iii) intercrystallite corrosion of stainless steels due to grain-boundary segregation of impurities; iv) pitting corrosion near nonmetallic inclusions; v) manyfold reduction in the rate of solution of the metal with a small degree of surface coverage by an inhibitor added to the solution or by atoms of an insoluble alloying element; vi) limitation of the rate of solution of a two-component alloy (solid solution) by the rate of ionization of one of its components. It is concluded that it is necessary to combine electrochemical methods of investigation of corrosion with other physicochemical and physical methods.

The question of the role of heterogeneity of a metal surface in initiation and development of the corrosion process is central to the science of corrosion of metals. In the history of this science there was a period in which corrosion resistance or the chemical resistance of metals and alloys was unambiguously related to the degree of heterogeneity of their surfaces. On this was based the first electrochemical theory of corrosion, known as the theory of local cells.

It was supposed that the corrosion of metals is the result of the operation of galvanic microcells on the surface of the corroding metal, due to chemical or structural inhomogeneity of different regions. In this connection it was proposed that the surface of a corroding metal should be regarded as a complex system, in general with many electrodes, in which the rate and distribution of the corrosion processes are governed by the electrochemical characteristics and area of the microelectrodes and by the resistance between them.

The fact that in many cases there is a qualitative correspondence between the amount of impurities in the metal and the rate of its corrosion, and the relative simplicity of the theory and the ease with which its basic idea was widely comprehended, made it popular among investigators, especially corrosion engineers. However, attempts to construct a quantitative theory of corrosion on this basis were unsuccessful.

In time it became evident that many experimental observations do not even qualitatively agree with the conclusions of the theory: It appeared that in many cases an increase in the heterogeneity of the surface does not lead to a decrease, but to an increase in the chemical stability of the material; moreover, on this basis it was impossible to explain the corrosion of very pure metals and amalgams without appealing to additional, physically improbable hypotheses.

From all this it followed that the idea of local microcells cannot serve as the basis for an electrochemical theory of corrosion or for a comprehensive account of the role of surface heterogeneity in corrosion processes.

The position is somewhat different for the present-day theory of electrochemical corrosion, which is based on the science of electrode processes including electrode equilibria and the laws of electrode reactions remote from equilibrium.

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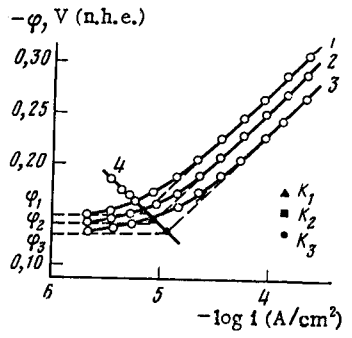

Fig. 1. Influence of potential of Ni electrode in 0.1 N HCl on density of cathodic current of evolution of H_2 (1-3) and on rate of ionization of Ni (4), calculated from results of polarization and volumetric (under cathodic polarization) measurements. Curve 1 and the open points on curve 4 refer to pure Ni; curves 2, 3 refer to Ni coated with various amounts of Pt. K_1, K_2, and K_3 are the corrosion rates of Ni, found from the volume of H_2 evolved.

According to this theory, the surface of a corroding metal, even if it is known to be inhomogeneous, can be regarded as a single electrode in the electrolyte solution, with the anodic and cathodic reactions, together composing the corrosion process, taking place on it simultaneously and statistically independently of one another.

At first these ideas were developed and experimentally verified in connection with the spontaneous solution of amalgams, i.e., surfaces which were known to be homogeneous [1, 2]. Later it was shown theoretically [3] and experimentally [4-7] that if the inhomogeneities in the media are microscopic in size and if the resistance is not very large, i.e., in conditions in which the equipotentiality of the surface is preserved, then these ideas also apply to corrosion processes on surfaces which are known to be inhomogeneous.

The first experimental support for this conclusion was obtained by the present author in collaboration with A. N. Frumkin [6] in an investigation of the laws of solution of nickel in acid solutions. In this investigation, with the aid of polarization measurements we determined the kinetics of the anodic reaction (ionization of nickel atoms) and the cathodic reaction (evolution of hydrogen), and by an independent method (from the volume of hydrogen evolved) we found the rate of spontaneous solution (corrosion) of nickel. By comparing the results we determined the applicability of the laws of electrochemical kinetics to the corrosion process. These experiments were performed both with pure nickel and with nickel with traces of platinum deposited on its surface.

The results are plotted in Fig. 1, in which curves 1-3 characterize the kinetics of evolution of hydrogen on the surface of pure nickel (1) and on the same surface after deposition of a known amount of platinum, increasing from curve 2 to curve 3, and curve 4 characterizes the kinetics of ionization of nickel; points K_1, K_2, and K_3 denote the rates of hydrogen evolution at corrosion potentials of φ_1, φ_2, and φ_3.

From the figure we see that deposition of small amounts of platinum on the nickel surface leads to marked acceleration of the cathodic reaction of hydrogen evolution, increasing with the amount of deposited platinum, but has no effect whatever on the kinetics of the anodic reaction of ionization of nickel. We also see that in all cases the points characterizing the rates of corrosion of nickel, determined by an independent method, coincide with the points of interaction of the anodic curve with the extrapolated continuations of the Tafel sections of the corresponding cathodic curves. This means that not only pure metal but also metal with a known heterogeneous surface corrodes, in this case, in complete conformity with the laws of electrochemical kinetics.

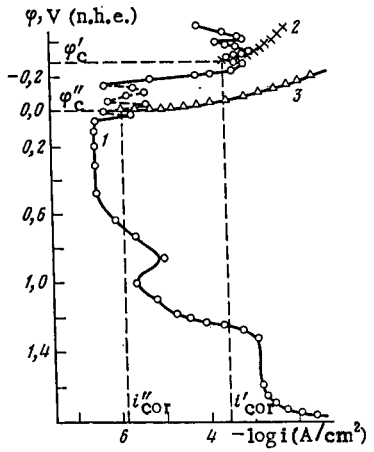

Fig. 2. Potential dependences of solution rate (1) and cathodic current density (2) for steel Kh2kT in 0.1 N H_2SO_4 (φ'_c and i_{cor}' are the corrosion potential and rate in these conditions); 3) cathodic polarization curve of the same steel after deposition of Pt (φ''_c and i_{cor}'' are the corrosion potential and rate in these conditions); curve 1 was obtained by analysis of the solution for its content of solution products.

It follows that in order to take account of the influence of the degree of heterogeneity on the integral rate of the corrosion process, in this case there is no need to know the number and area of the regions of the surface which differ in composition and structure from the main phase, or the character of their distribution over the surface. The influence of heterogeneity qualitatively and quantitatively affects the experimentally determined kinetic characteristics of the cathodic and anodic reactions, and consequently the characteristics of the corrosion process itself.

Thus, in principle not only the integral rate of the corrosion process, but also the way in which this rate is influenced by changes in the degree and character of the surface inhomogeneity, can be assessed from the results of electrochemical measurements.

From the electrochemical viewpoint the above system is typical. In principle, its corrosion behavior is uniquely determined by the anodic characteristics of the main phase, in this case nickel. If we know this characteristic, then to estimate the corrosion rate we need only additionally measure the corrosion potential. This is because deposits of platinum, like many other inclusions, are active only in relation to the depolarizing cathodic reaction – evolution of hydrogen – so that their appearance on the surface of the main phase influences only the value of the corrosion potential.

It is, however, important that, according to the anodic characteristics of the main phase a progressive increase in the amount of cathodic inclusions on its surface can lead either to an increase or to a decrease in the corrosion rate. Retardation is observed when, in its own progressive rise, the corrosion potential first reaches and then begins to exceed the critical potential of passivation of the main phase.

Some time ago this case was discussed by us in an investigation of the corrosion behavior of steel Kh22T in sulfuric acid solution [8]. The anodic and cathodic characteristics of this steel are plotted in Fig. 2, curves 1 and 2, respectively. We see that the potential and corrosion rate (expressed in units of electric current) characterizing the points of intersection of these curves have values of -0.290 V and $3.5 \cdot 10^{-4}$ A/cm^2, respectively. Deposition of small amounts of platinum on the surface of the steel led to a shift in the corrosion potential to 0.00 V and to a nearly hundredfold reduction in the corrosion rate.

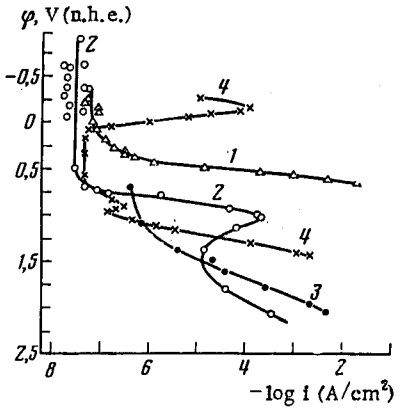

Fig. 3. Potential dependences of rates of solution of Mo_2C (1), TiC (2), NbC (3), and steel Kh18N10T (4) in 1 N H_2SO_4 at 22°C.

It is evident that in this case the curve characterizing the dependence of the corrosion rate on the degree of surface coverage of the metal by a cathodically active substance must have a maximum, which is evidence of a transition of the corroding phase from the active to the passive state. Such a transition is often spontaneous, i.e., the metal is capable of spontaneous passivation. This is usually observed when the cathodically active substance is contained in the structural material itself and accumulates on the surface as the latter corrodes. An example of this is the phenomenon, discovered by Tomashov [9], of enhanced corrosion resistance of titanium in reducing acidic media when it is alloyed with small quantities of palladium or another metal with a low hydrogen overvoltage. Palladium, gradually accumulating on the surface of the titanium as the latter dissolves, catalytically accelerates the cathodic reaction in the direction of hydrogen and thus shifts the corrosion potential toward the passivation potential. Note, by the way, that self-passivation by this mechanism is possible only if corrosion occurs with hydrogen depolarization and the passivation potential of the material is more negative than the potential of a reversible hydrogen electrode in the same solution.

The pattern becomes much more complex if we change to commercial alloys, many of which have at least two phases and, as a rule, contain so-called secondary phases or interstitial phases.

In this case the anodic polarization curve is merely an average characteristic of the material as a whole and gives no idea of the reactivities of the individual structural components, which may differ markedly among themselves. As a result there may be a nonuniform distribution of the rate of the anodic process over the surface, i.e., preferential solution of some phases and enrichment of the surface with others, which must unavoidably alter not only the cathodic but also the anodic characteristics of the material and must be accompanied by changes in its corrosion behavior with time.

Moreover, the reactivity of such a material cannot be reduced to the reactivities of its individual constituent phases. Their accumulation on the surface of steel in acidic media is therefore accompanied in each case by a marked increase in the rate of the depolarizing cathodic reaction, which in turn shifts the corrosion potential toward the positive. As a rule, after a time this displacement becomes sufficient to reach the passivation potential, causing a spontaneous transition of the steel to the passive state, and consequently a marked increase in its stability [10-12].

This is manifested in the beneficial influence of carbides on the stability of stainless steels in acidic media. Owing to this effect, in these media it is better to use steels stabilized with titanium or niobium than steels which are very free of carbon [13].

However, it is important that on attainment of sufficiently positive potentials corresponding to the region of deep passivation of steels, the stability of carbides is sharply reduced [10, 14, 15]: They begin to be oxidized, and the rate of this process usually increases with rise of potential in accordance with the Tafel line (Fig. 3). The most easily oxidized carbide is Mo_2C, which begins to dissolve anodically at appreciable and

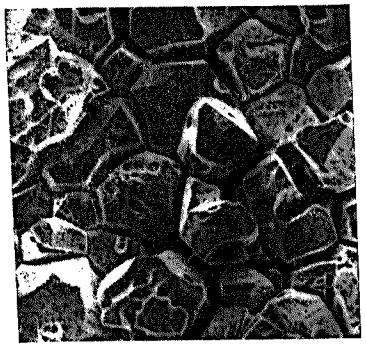

Fig. 4. Intercrystallite corrosion of hardened steel, Fe–20% Cr–20% Ni–0.1% P, in 27% HNO_3 at 40°C in transpassivation region; × 1000.

progressively rising rates at 0.4 V (1 N H_2SO_4, 22°C). Marked oxidation of TiC begins at potentials on the positive side of 0.7 V, i.e., in just that region in which steel stabilized with titanium has a reduced corrosion resistance. There can be no doubt that these two phenomena are mutually related. In particular, evidence for this is the relative increase of the titanium content in the solution products of the steel when it enters this range of potentials. However, a more detailed analysis reveals that the observed increase in the rate of solution of the carbide constitutes only a small part of the total increase in the rate of solution of the steel. Consequently, in this case solution of carbide is accompanied by marked acceleration of the solution of the main phase. From this, in turn, it follows that in very oxidative media, steels with reduced carbon contents should behave better, from the corrosion aspect, than steels alloyed with titanium.

In contrast with titanium carbide, niobium carbide has high stability in oxidizing media. It is oxidized at appreciable rates only at potentials more positive than 1.4 V (Fig. 3), at which stainless steels are not usually used.

The above results indicate that, according to the conditions, the influence of carbides and other interstitial phases on the corrosion resistances of steels may be either disadvantageous or beneficial. Regulation of the phase composition is therefore a promising way of improving the chemical stability of this and, apparently, other types of structural alloys.

The influence of surface heterogeneity on the corrosion behavior of structural metallic materials is manifested not only when the material is active but also, and perhaps more markedly, when it is passive. This is undoubtedly because the protective effectiveness of the passivating film is very sensitive to the composition and structure of the surface layer of metal; depending upon this, in some regions it will have better protective characteristics, in others worse.

It is also important that in this case (a passive metal) the initial nonuniformity of the distribution of the rate of the anodic process over the surface, due to the heterogeneity of the material itself, may be enhanced by secondary phenomena, caused, in particular, by preferential migration of aggressive anions to the least protected and hence the most anodically active parts of the surface. In certain conditions, accumulation of anions in these regions can lead to local depassivation of the surface of the metal and to development of local forms of corrosion.

It is now well known that one of the most corrosion-vulnerable sites on a passive surface is that part which adjoins the grain boundaries, the reduced chemical stability of which is in most cases due to depletion of the adjoining thin layers of metal in one of the most stable components of the material or to segregation of particular technological impurities in these layers, impairing the protective properties of the passivating films. For example, in the case of stainless steels the cause of their intercrystallite corrosion in weakly oxidizing media is depletion of chromium from the grain boundaries, this metal being the component with the greatest liability to passivation. This hypothesis was advanced a fairly long time ago, and has recently been confirmed by direct experiment: With the aid of radioactive indicators [16] it has been shown that in the intercrystallite corrosion of steels in these conditions, the corrosion products contain a reduced quantity of chromium in comparison with the mean content in the steel.

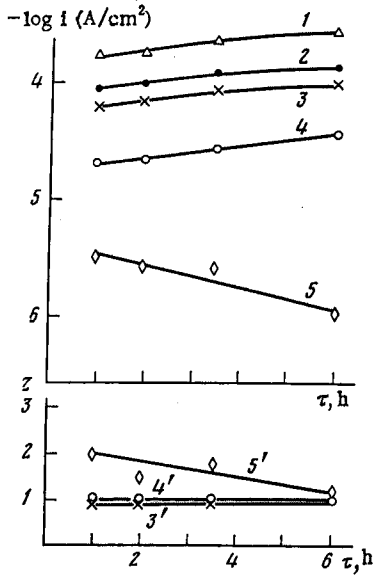

Fig. 5. Total (1) and partial (2-5) rates of solution of components of hardened steel Fe−20% Cr−20% Ni−0.1% P and coefficients of selective solution Z (3'-5') vs time of anodic pickling in 27% HNO_3 at 40°C and 1.27 V (rel. to n.h.e.): 2) Fe; 3, 3') Cr; 4, 4') Ni; 5, 5') P.

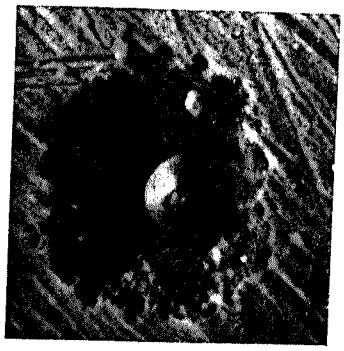

Fig. 6. Pitting near nonmetallic inclusion.

The possibility of reduction in chemical stability of the grain boundaries on account of segregation of technological impurities is indicated by data obtained by Kasparova et al. [17], who investigated the influence of phosphorus as an impurity on the corrosion behavior of steel Kh20N20. As seen from Fig. 4 [18], in the presence of this impurity, steel is subjected to marked intercrystallite corrosion; the concentration of phosphorus in the products of this corrosion, determined by a photocolorimetric method, is greater than the mean content in the steel (Fig. 5).

As shown by investigations recently made in our laboratory by Freiman [19], weak sites in passive surfaces are often regions adjoining nonmetallic inclusions, especially of sulfides. It is in these regions that we most often observe the formation and development of pitting [20] (see Fig. 6).

It has recently become increasingly obvious that the explanation of certain important features of the corrosion behavior of metallic structural materials must be sought in the subheterogeneity of their surfaces, i.e., heterogeneity due to nonuniform energy positions of different atoms in the surface layer of the metal, which has the result that they have different reactivities. Among these features we must single out a phenomenon which has been well established experimentally − a manyfold reduction in the rate of anodic solution of the metal or alloy by adsorbed inhibitors when the degree of surface coverage of the metal by the inhibitors is only a fraction of a monomolecular layer. Some authors have supposed that there is some sort of mechanism

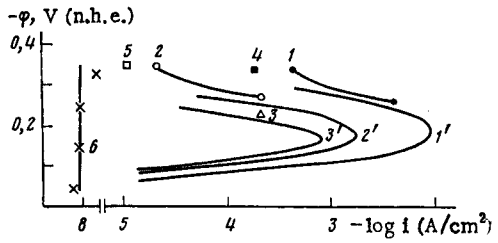

Fig. 7. Potential dependences of stationary solution rate (1-6) and potentiodynamically (0.9 V/h) recorded anodic polarization curves (1'-3') for the alloys Fe–18% Cr (1, 1'), Fe–18% Cr–2% Mo (2, 2'), Fe–18% Cr–3% Mo (3, 3'), Fe–26% Cr (4), and Fe–26% Cr–2% Mo (5), and also Mo (6), in 1 N H_2SO_4 at 22°C.

of long-range action of adsorbed particles at distances much greater than their actual radii. However, recent research has shown that it is more correct to seek the explanation of this phenomenon in the topography of solution of solid metallic surfaces; the importance of this was observed some time ago by Stranskii.

There is every reason to suppose that in the solution of a solid metal in an electrolyte the rate of the process is distributed over the surface very nonuniformly and that at each given moment the main contribution to the measured rate is made by solution of a relatively small number of very active centers, which, however, are not always strictly fixed but can migrate over the surface. These centers might be various kinds of jogs, emergences of dislocations, and other sites where metal atoms have a minimum degree of saturation of free valence bonds and consequently interact more easily with the solution.

It has been suggested that blocking of such centers by adsorbed inhibitor molecules explains the manyfold retardation of the anodic process by low surface coverages with inhibitor.

The fruitfulness of this approach can be demonstrated from the results of our recent investigations [21] of the retardation of the anodic solution of stainless steels by alloying them with small quantities of molybdenum in conditions in which the surface is in the active state. It is known that the effectiveness of added molybdenum is particularly great when it is present in small amounts in the steel.

As seen in Fig. 7, the potential dependence of the solution rate for steel Fe–18% Cr is characterized in this case by a Tafel line either with or without molybdenum. Introduction of molybdenum and increase in its amount lead merely to parallel displacement of this line toward more positive potentials, i.e., to some retardation of the process. This means that addition of molybdenum alters only the rate but not the mechanism of solution; the latter remains electrochemical. However, for each molybdenum content the characteristic limiting retardation of the process is established only after a certain period of interaction of the steel with the solution, whereas in the initial stage the rates of solution of steels with molybdenum are similar to those without molybdenum.

The results of measurements of the partial rates of solution of the components of steel by the method of radioactive indicators, and also the results of x-ray microanalysis of the surface, have shown that during this initial period molybdenum accumulates on the surface.

Special experiments revealed that the observed retardation of the process cannot be explained by screening of the surface by molybdenum oxides accumulated on it. However, this retardation becomes intelligible if we remember, as shown above, that solution of steel occurs nonuniformly and that the main contribution to the overall rate of the process is made by solution of a relatively small number of very active centers.

If we assume that these centers are projecting atomic steps, then, as shown in Fig. 8, solution of the metal is mainly due to successive transition of atoms from position E to positions J and S. Since the process rate at each step is determined by the lifetime of an atom on a jog, therefore, owing to lack of compensation of the valence bonds of this atom, the rate must be to a considerable extent determined by those electrochemical properties which the atom possesses when in an analogous position on the surface of its own phase. If, therefore, there is a molybdenum atom at the jog, liable to go into the passive state in the conditions in question on account of interaction with oxygen of water, the lifetime of atoms staying on the step becomes longer.

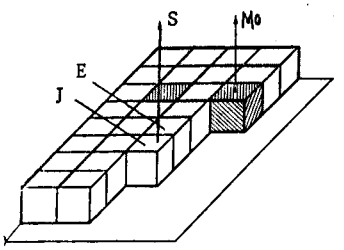

Fig. 8. Schematic model of surface of steel containing molybdenum; J indicates jog; E indicates edge of atomic step.

Since the numbers of steps containing iron and chromium atoms at their jogs are similar on the original surfaces of steels with and without molybdenum, the rates of solution of these steels in the initial stage of contact with the solution will also be similar. However, as time passes, i.e., as iron and chromium go into solution, there is an increase in the proportion of steps blocked by molybdenum, and the rate of solution of the steel therefore decreases. Clearly, this mechanism can also cause blocking of other active microregions of the real surface – emergences of dislocations, vacancies, and other defects.

Thus, in our case and, i.e., in the case of inhibition of solution of nickel by iodine ions [22], the retardation of the process is due to blocking of an active center by components of the medium which are strongly adsorbed on it. However, whereas inhibition is usually due to modification of the aggressive medium by an additive whose molecules can interact strongly with the main component of the alloy, in the present case inhibition is due to modification of the metal itself by the additive, whose atoms can react strongly with the main component of the aggressive medium, i.e., water molecules.

Changes in composition, and consequently in the cathodic and anodic characteristics of the surface layer of a metal during corrosion, i.e., with time, must be taken into account in assessing the behavior not only of multiphase heterogeneous alloys, but also of solid solutions. As shown by recent investigations, in this case, as a rule, it is necessary to take account of the possibility of selective solution of some compounds and accumulation of others on the surface, and consequently of the possibility of changes, not only in the kinetic parameters of the process, but also in its mechanism.

For example, from general considerations it follows that when a solid solution dissolves in stationary conditions, its components must go into the electrolyte solution in the same proportions as those in which they are present in the alloy. For a two-component alloy, the partial rates of solution in these conditions must be strictly related by the expression

$$(i_1/i_2) = (N_2/N_1) \cdot (X/[100-X]), \quad (1)$$

where i_1 and i_2 are the partial rates of solution of components 1 and 2, N_1 and N_2 are their electrochemical equivalents, and X is the content of component 1 in the alloy in weight percent.

However, since the components of a solid solution, as a rule, differ in their position in the electromotive series and in their anodic solution kinetics, relation (1) is preserved only if one of the following two conditions is satisfied: a) the kinetic characteristics of solution of the given component from the alloy can appreciably differ from the kinetic characteristics of its solution in the individual state; b) solution of the solid solution in stationary conditions follows a mechanism such that the passage of different components into the solution is limited by different stages.

As we have recently demonstrated in an investigation made in collaboration with Florianovich and Shirinov [23], the latter case is realized in the solution of iron–chromium alloys in acid sulfate solutions at 50°C.

In this investigation, a combination of electrochemical, radiometric, and analytical methods was used to determine the way in which the total rate of solution of the alloy and the partial rates of passage of both its components into solution in stationary conditions depends on the potential and solution pH. The results are listed in Table 1. For comparison we also give analogous data for pure iron and chromium.

TABLE 1. Kinetic Characteristics of Fe and Cr during Solution from the Pure Metals and Alloys of Various Compositions

Cr content of alloy, %	$(\partial \lg i/\partial pH)_\varphi$		$(\partial\varphi/\partial \lg i)_{pH}$, mV		Cr content of alloy, %	$(\partial \lg i/\partial pH)_\varphi$		$(\partial\varphi/\partial \lg i)_{pH}$, mV	
	Fe	Cr	Fe	Cr		Fe	Cr	Fe	Cr
0	1,0	–	50	–	13,2	0,0	0,0	80	80
0,85	0,9	0,9	50	50	27,9	0,0	0,0	80	80
6,95	0,35	0,35	45±5	45±5	100	–	0	–	90

From this table we see that the alloys can be divided into two groups, according to the character of the dependence of the partial rates of solution of the alloy components on the potential and pH. For alloys with a low chromium content, for both components these characteristics agree with the corresponding characteristics for pure iron. Alloys containing 13% or more of chromium correspond to the characteristics of pure chromium.

Hence, e.g., it follows that solution of iron from alloys containing small amounts of chromium occurs in kinetic conditions, i.e., it is limited by the electrochemical stage of ionization of iron, and this stage limits not only the rate of solution of iron itself but the whole process of solution of all of the alloy.

Thus, ending our discussion, we can conclude that if a material is one-component and one-phase and the reacting solid surface is homogeneous and corrosion is not complicated by secondary phenomena or parallel reactions, the corrosion process can be described on the basis of a simple kinetic analysis of the results of electrochemical measurements, leading to comparatively simple relations. If we pass even to homogeneous but multicomponent materials, the position becomes much more complicated. It is even more difficult to describe the corrosion behavior of multiphase systems. In this case the additivity principle is not always applicable. Very often we observe direct or indirect mutual influence of phases, and not infrequently there are cases in which, depending on the conditions, the same structural component of the material can either increase or reduce the rate of damage to the main phase and thus alter the chemical stability of the whole material. However, all this does not exclude the possibility of using electrochemical methods to estimate the overall corrosion rate of such a heterogeneous material. In this case we must merely bear in mind the fact that the overall corrosion rate is far from the only characteristic of the chemical stability of the material. In estimating this stability, equal importance attaches to the character of the distribution of the corrosion process over the surface. This characteristic, like the role of the individual structural components of the material in the development of the corrosion process, cannot be assessed by electrochemical methods alone; in this case they must be combined with other physicochemical and physical methods, including metallography, various types of tagged-atom methods, x-ray and nuclear microanalysis, Auger electron spectroscopy, etc.

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PROBLEMS AND PROSPECTS FOR AUGER SPECTROSCOPY IN CORROSION AND ELECTROCHEMICAL RESEARCH

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The possibilities of Auger electron spectroscopy in qualitative and quantitative elemental analysis of monolayers and their electron states are illustrated by examples from corrosion and electrochemistry. This survey gives the principles of the method and also discusses important methodological problems, such as detection of traces of elements, damage to the samples by the electron probe, indeterminacy of the theoretical parameters in quantitative analysis, selectivity of ion sputtering in layerwise investigations, etc. The analytical prospects for Auger electron spectroscopy are also briefly discussed.

INTRODUCTION

The rapid progress of Auger electron spectroscopy has brought it into the ranks of the principal methods of surface diagnostics in the fields of elemental analysis of monolayers and determination of their electron states. Since the intensity and kinetics of corrosion and electrochemical processes depend to a considerable, often decisive, extent on the state of the surface, the importance of Auger spectroscopy in corrosion and electrochemical research is continually increasing. Methodological problems have, however, arisen, and if ignored they may distort the information obtained by the method, and may lead to incomplete utilization of its capabilities.

In this survey, which is aimed at chemists who are familiar in general outlines with the Auger spectroscopy method, we aim to illustrate its capabilities, limitations, and prospects by means of particular examples from the fields of corrosion and electrochemistry.

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