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Strain rate sensitivity of mechanical properties of the ZK60 alloy with the high degree of corrosion damage

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Abstract: There is a strong belief that hydrogen absorbed by magnesium alloys during corrosion can cause their stress corrosion cracking. One of the characteristic markers indicating the involvement of diffusible hydrogen into the fracture mechanism of metals is the negative strain rate dependence of the embrittlement degree. Recent studies show that the loss of ductility of the ZK60 alloy specimens subjected to a short-term (1.5 h) pre-exposure in a corrosive medium actually decreases with the increasing strain rate. However, after the removal of corrosion products from the surface of the specimens, the strain rate dependence of the ductility loss becomes positive, which indicates the absence of hydrogen in the bulk of the metal. At short-term exposure in a corrosive environment, the deep penetration of hydrogen into a metal could be limited due to the insufficient time for hydrogen diffusion. The paper studies the mechanical behavior of the ZK60 alloy subjected to a longer (12 h) pre-exposure in a corrosive medium followed by tensile testing in air at various strain rates. The authors consider the effect of strain rate, long-term pre-exposure in a corrosive medium, and subsequent removal of corrosion products on the strength, ductility, stages of work hardening, and localized deformation, as well as on the state of the side and fracture surfaces of specimens. It is established that the ductility loss of the specimens pre-exposed in a corrosive medium for 12 h decreases with the increasing strain rate, regardless of whether the corrosion products have been removed from their surface or not. It is shown that in this case, the negative strain rate dependence of the ductility loss is associated not with hydrogen dissolved in the bulk of a metal but with the presence of severe corrosion damage of the specimens' surface. An explanation for the effect of corrosion damage on the mechanical properties and their strain rate sensitivity is proposed.

Keywords: magnesium alloys; ZK60 alloy; stress corrosion cracking; corrosion; strain rate; mechanical properties.

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INTRODUCTION

Magnesium-based alloys with the unique complex of mechanical properties are the promising structural material for many manufacturing sectors, including automotive, air-space, and other industries. Moreover, magnesium alloys find their application as a material for bioresorbable implants, which can dissolve in a human body after performing their function. However, their low resistance to corrosion and stress corrosion cracking (SCC) is a great obstacle to a wider application of magnesium alloys in the specified areas.

Fracture of magnesium alloys in aggressive media can occur under the stresses significantly lower than the yield stress [1–3]. Despite the fact that, lately, the scientific community aims the significant efforts at the solution of the SCC problem, many issues related to the nature of the behavior of magnesium under the effect of a corrosive medium remain open. Particularly, there is not a uniform point of view about the SCC mechanism. This phenomenon develops as a result of the simultaneous exposure of a mechanical stress and corrosive environment and can lead to the embrittlement of the majority of magnesium alloys [4–6]. The most common hypothesis is that the main cause of such embrittlement is hydrogen, which is formed and penetrates into the metal in the process of the corrosion reaction [7–9]. As an argument for this hypothesis, the fact is often mentioned that magnesium alloys are subjected to the so-called pre-exposure stress corrosion cracking (PESCC), which develops as a result of preliminary exposure of the metal to a corrosion environment and manifests itself in the form of a decrease in its mechanical properties and the appearance of a brittle component on a fracture surface during the subsequent mechanical tests in air.

Since the specimen does not come into contact with an aggressive environment directly during the mechanical tests, the observed embrittlement is associated with hydrogen absorbed by the metal in the process of preliminary exposure to a corrosive solution [13–15]. This phenomenon was observed in many magnesium alloys, which were held in corrosive media of various compositions [16–18]. Moreover, it was found that the reduction in the mechanical properties decreases with the increasing strain rate [19; 20]. Such a result is considered as an additional evidence of hydrogen participation in the PESCC mechanism [20], since the negative rate dependence of the loss of ductility is a characteristic feature of many metals and alloys embrittled by hydrogen [21; 22]. This dependence is explained by the fact that with an increase in the strain rate, a smaller amount of hydrogen is able to diffuse to the crack tip; therefore, the crack propagates at a higher external stress rather than in the presence of hydrogen. Recent studies of the ZK60 and AZ31 alloys have shown that the PESCC-associated embrittlement can be completely eliminated by the corrosion products removal from the specimen surface before testing in air, providing that the specimen surface is not severely damaged by anodic dissolution, during the pre-exposure to a corrosive environment [19; 23; 24]. At the same time, gas analysis of specimens with the removed corrosion products showed that the concentration of diffusible hydrogen in their volume is low [23; 24]. Later, it was identified that the negative strain rate dependence of the loss of ductility of specimens kept in a corrosive environment for 1.5 h becomes positive (the same as for specimens not exposed to a corrosive environment) after the corrosion products removal from the surface [19]. Based on the results, the authors concluded that the main reason for the PESCC-associated embrittlement is not hydrogen dissolved in the bulk of the metal but the embrittling agents, such as hydrogen or residual corrosive environment in the layer of corrosion products [19; 23; 24]. However, the study of the effect of the strain rate was carried out in the work [19] on the specimens kept in a corrosive environment for a relatively short period of time – for 1.5 h. It can be suggested that during this time, hydrogen did not have enough time to penetrate deeply into the bulk of the metal, therefore, it quickly escaped from the surface layer to the atmosphere after the removal of corrosion products.

In this regard, it is reasonable to carry out the research of the strain rate effect on the PESCC of the ZK60 alloy subjected to a longer exposure. It is important to emphasize that the previous works showed that the increase in the time of exposure of the ZK60 alloy specimens to a corrosive environment from 1.5 h to 12 h leads to the severe corrosive damages [23], which also can influence the mechanical properties and their sensitivity to a strain rate change.

The work is aimed to clarify the role of hydrogen and irreversible corrosive damage to a surface in the PESCC mechanism of ZK60 alloy.

METHODS

The ZK60 commercial alloy produced by the hot extrusion was used as a research material. The alloy chemical composition identified using the ARL 4460 optical-emission spectrometer (Thermo Fisher Scientific) is shown in Table 1. The alloy has a microstructure with an average α-phase grain size of 3 μm. The microstructure images and its detailed description are given in one of the previous works [25].

The threaded cylindrical specimens for tensile tests with a gauge part of 6×30 mm in size were machined from a rod with a diameter of 25 mm along the extrusion direction. The obtained specimens were soaked at open-circuit potential in an aqueous corrosion solution of 4 % NaCl + + 4 % $K_2Cr_2O_7$ (the same solution was used in the work [19]) for 12 h at room temperature (24 °C) without applying the external mechanical stress. During soaking, only the specimen gauge part was in contact with the corrosive solution. After the exposure, the specimens were removed out of the corrosive environment and cleaned in an ethanol jet, and then dried with compressed air. Corrosion products were removed from some specimens immediately after the exposure by dipping specimens in a standard aqueous solution C.5.4 (20 % CrO_3 + 1 % $AgNO_3$) as per GOST R Standard 9.907 for 1 min, followed by rinsing with ethanol and drying with compressed air. Within 5 min after the end of exposure or corrosion products removal, a tensile test of a specimen was started, which was carried out in air at room temperature at constant initial strain rates in the range from $5\cdot10^{-6}$ to $5\cdot10^{-4}$ s^{-1} (from 0.01 up to 1 mm/min) using the AG-X plus testing machine (Shimadzu).

For the reference, similar tests were conducted on specimens in the initial (reference) state, which were not subjected to exposure to a corrosive environment. After tests, the fracture and side surfaces of fractured specimens were analyzed using the SIGMA scanning electron microscope (Carl Zeiss).

RESULTS

Mechanical properties

Mechanical tests have shown (Fig. 1) that at the same strain rate, both the strength and ductility of specimens decrease remarkably as a result of exposure to a corrosive

Table 1. *Chemical composition of the ZK60 alloy, % wt.*
Таблица 1. *Химический состав сплава ZK60, вес. %*

Mg	Al	Zn	Ca	Zr	Fe	Cu	Mn	Ce	Nd	Si
Base	0.002	5.417	0.0004	0.471	0.001	0.002	0.005	0.002	0.003	0.003

environment (Fig. 1 a, 1 b). In this case, the mechanical properties of the specimens are partially restored after the corrosion products removal. It has been identified that with an increase in the strain rate, the elongation of the specimens in the reference state decreases significantly, while their strength increases. At the same time, the ductility of specimens, which were exposed to a corrosive medium before testing, slightly changes with an increase in the strain rate regardless of whether the corrosion products were removed from them or not. The strength of specimens kept in a corrosive environment increases with an increase in the strain rate, but is much weaker than that of specimens in the reference state.

Since the mechanical properties of specimens in the reference state vary greatly depending on the strain rate, to assess the rate sensitivity of the alloy embrittlement degree, it is reasonable to use the value of the ductility and strength loss with respect to the specimens in the reference state at a given strain rate. The research identified that the value of the ductility loss of specimens exposed to a corrosive environment decreases with the increase in the strain rate, while the strength loss, on the contrary, increases (Fig. 1 c, 1 d). This statement is true both for specimens with the removed corrosion products and for those from which the corrosion products were not removed.

The appearance of the strain-stress diagrams obtained during the testing of the specimens (Fig. 2) indicates that the decrease in the elongation of the specimens in the reference state as a result of an increase in the strain rate occurs mainly due to the reduction of the localized deformation part of the strain-stress diagram, while the change in the length of the strain hardening region is much less pronounced. This pattern is clearly demonstrated in Fig. 3, which shows the graphs of the change in the length of

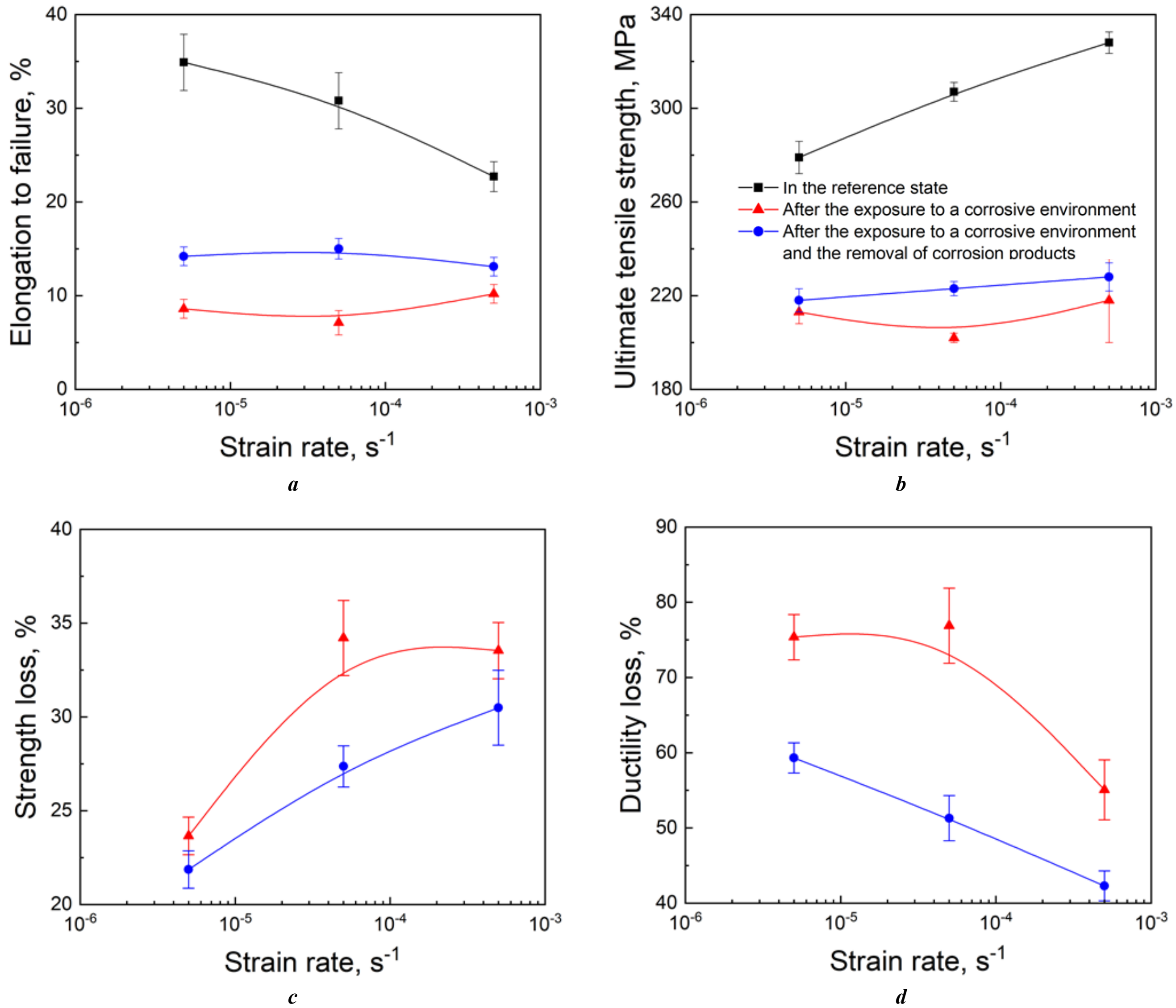

Fig. 1. *The effect of strain rate on:*
a *– the elongation to failure;* ***b*** *– the ultimate tensile strength;*
c *– the ductility loss;* ***d*** *– the strength loss of the ZK60 alloy in different states*
Рис. 1. *Влияние скорости деформирования на:*
a *– относительное удлинение;* ***b*** *– предел прочности;* ***c*** *– потерю пластичности;*
d *– потерю прочности образцов сплава ZK60 в разных состояниях*

the strain hardening – δ_{SH} and localized deformation – δ_l parts depending on the strain rate for specimens tested in different states. According to the dependencies in Fig. 3, δ_l decreases much more than δ_{SH} as a result of soaking in a corrosive environment. Moreover, after the corrosion products removal, δ_{SH} increases to a level corresponding to the specimens in the reference state, while δ_l just scarcely recovers. The δ_{SH} and δ_l values for specimens kept in a corrosive environment weakly depend on the strain rate, regardless of whether the corrosion products were removed from the specimens' surface or not. It should be noted that for these specimens, with the increase of the strain rate, δ_{SH} slightly increases, while δ_l slightly decreases.

The analysis of fracture and side surfaces

Fig. 4 a–f indicates that the side surface of the specimens kept in a corrosive environment before testing has a typical hummocky relief formed as a result of uneven dissolution of the specimen during the soaking in a corrosive environment. To compare, Fig. 4 g–i shows the images of the side surfaces of the specimens in the reference state, which have a completely different relief without any signs of corrosion damage.

It is important to note that on the side surface of the specimens, from which the corrosion products were not removed after the exposure to a corrosive medium, there are numerous cracks oriented perpendicularly to the tensile axis (Fig. 4 a–c). At the same time, the specimens, from which the corrosion products were removed, do not exhibit such cracks (Fig. 4 d–f).

The fractographic analysis showed that in the peripheral part of the fracture surface of the specimens tested after soaking in the medium without the corrosion products removal, there is a typical annular zone with the brittle fracture morphology, the area of which decreases with an increase in the strain rate (Fig. 5 a–c). At the same time, in the specimens, from which the corrosion products were removed before the start of the test (Fig. 5 d–f), as well as in the specimens in the reference state (Fig. 5 g–i), the fracture surfaces are completely ductile without any signs of brittle fracture regardless of the strain rate.

DISCUSSION

According to the results obtained, the loss of ductility, the value of which characterizes the degree of the alloy embrittlement as a result of PESCC, decreases with an increase in the strain rate for all specimens kept in a corrosive environment for 12 h, including those, from which the corrosion products were removed after the soaking. At the same time, one of our recent works shows that the loss of ductility of the same alloy after keeping in a corrosive environment for 1.5 h and the subsequent corrosion products removal, on the contrary, increases with an increase in the strain rate [19]. Moreover, if the corrosion products were not removed from the specimens' surface after 1.5 h of soaking, the loss of ductility decreased with an increase in the strain rate in the same way as after 12 h of soaking in the present work.

Holding a generally accepted point of view, according to which the negative strain rate dependence of the ductility loss of magnesium alloys during the SCC and PESCC processes is associated with diffusible hydrogen dissolved in them [13; 15; 20], the behavior of the ZK60 alloy mechanical properties depending on the strain rate found in the present and previous [19] works can be wrongly interpreted as follows. As a result of a relatively short exposure to a corrosive environment for 1.5 h, hydrogen does not have enough time to deeply penetrate into the bulk of the metal

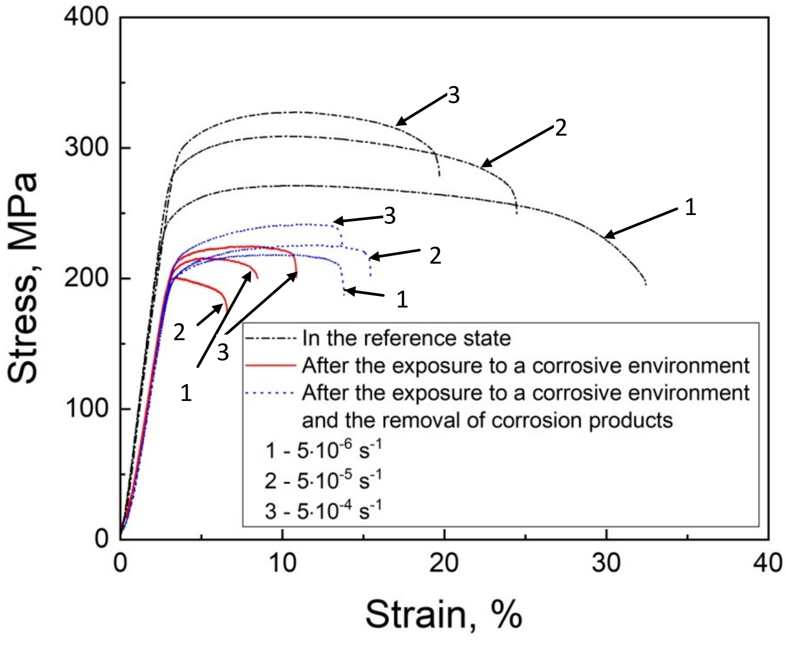

Fig. 2. *The effect of strain rate on the stress-strain diagrams of the ZK60 alloy specimens in different states*
Рис. 2. *Влияние скорости деформирования на диаграммы растяжения образцов сплава ZK60 в разных состояниях*

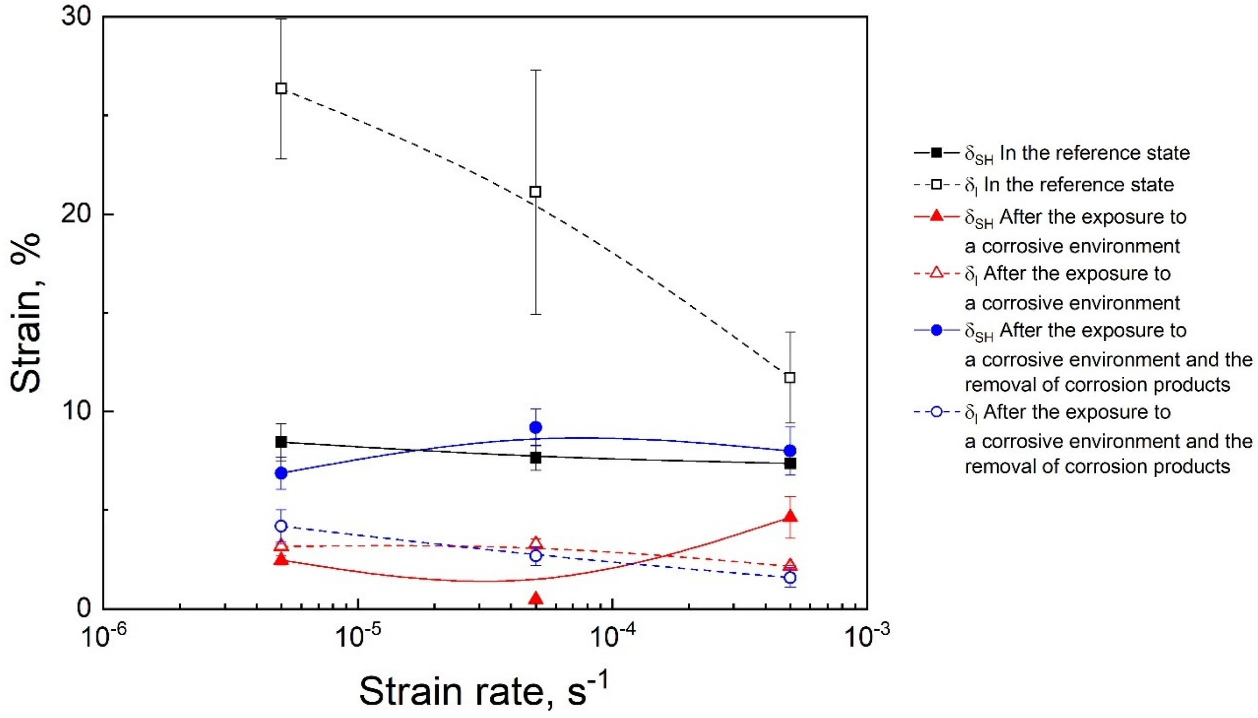

Fig. 3. *The effect of strain rate on the length of strain-hardening – δ_{SH} and localized deformation – δ_l parts of the stress-strain diagrams of the ZK60 alloy specimens in different states*
Рис. 3. *Влияние скорости деформирования на длину участка деформационного упрочнения – δ_{SH} и локализованной деформации – δ_l на диаграммах растяжения образцов сплава ZK60 в разных состояниях*

matrix and is located in the surface layer under the crust of corrosion products preventing its exit from the specimen. Therefore, when retaining a layer of corrosion products on the specimens' surface during the tensile tests, hydrogen participates in the mechanism of nucleation and growth of brittle cracks, which ultimately leads to a premature fracture of the alloy, a decrease in its ductility, and the formation of a brittle zone on the fracture surface. With an increase in the strain rate, the amount of hydrogen that has enough time to diffuse to the crack tip decreases, therefore, the loss of ductility decreases. If the corrosion products are removed from the specimens' surface, then hydrogen is rapidly desorbed from the surface layer into the atmosphere, which leads to the recovery of the alloy ductility and a qualitative change in the dependence of the loss of its ductility on the strain rate. With a longer soaking in a corrosive environment for 12 h, hydrogen has enough time to penetrate much deeper into the bulk of the metal and, therefore, is not completely removed from the specimens after the corrosion products removal. For this reason, both the specimens with the removed corrosion products and those from which the corrosion products were not removed demonstrate a decrease in the loss of ductility with an increase in the strain rate.

An important argument against such an interpretation of the results obtained is the fact that the specimens, from the surface of which the corrosion products were removed after 12 h of exposure, demonstrate the total absence of a brittle zone on the fracture surface and brittle secondary cracks on the side surface, regardless of the strain rate at which the test was carried out. Thus, the change in the loss of ductility of these specimens with an increase in the strain rate cannot be associated with the suppression of the brittle fracture mechanism, which is an intrinsic feature of the hydrogen embrittlement. Indeed, previous works show that the hydrogen concentration in the specimens kept in a corrosive environment, including for 12 h, and from which the corrosion products were then removed, is insignificant [23; 24]. The authors made an assumption that the main reason for the embrittlement of the specimens pre-exposed to a corrosive environment is the embrittling agents, such as hydrogen or residual corrosive environment located in the corrosion products layer [19; 23; 24]. The details of this mechanism will be researched in future studies. In the present work, it is reasonable to consider the features of the rate dependence of the properties of specimens with the removed corrosion products, in which these embrittling agents are totally absent.

If the fracture of specimens with the removed corrosion products occurs according to the common ductile mechanism, the same as for specimens in the reference state, the same character of the dependence of ductility on the strain rate for these two types of specimens should also be expected. In particular, this is exactly what was observed when the exposure time was 1.5 h [19]: the ductility of the specimens, both in the initial state and after the corrosion products removal, decreased with an increase in the strain rate, and, moreover, for the specimens with the removed corrosion products, a decrease in ductility with an increase in the strain rate was even stronger than that

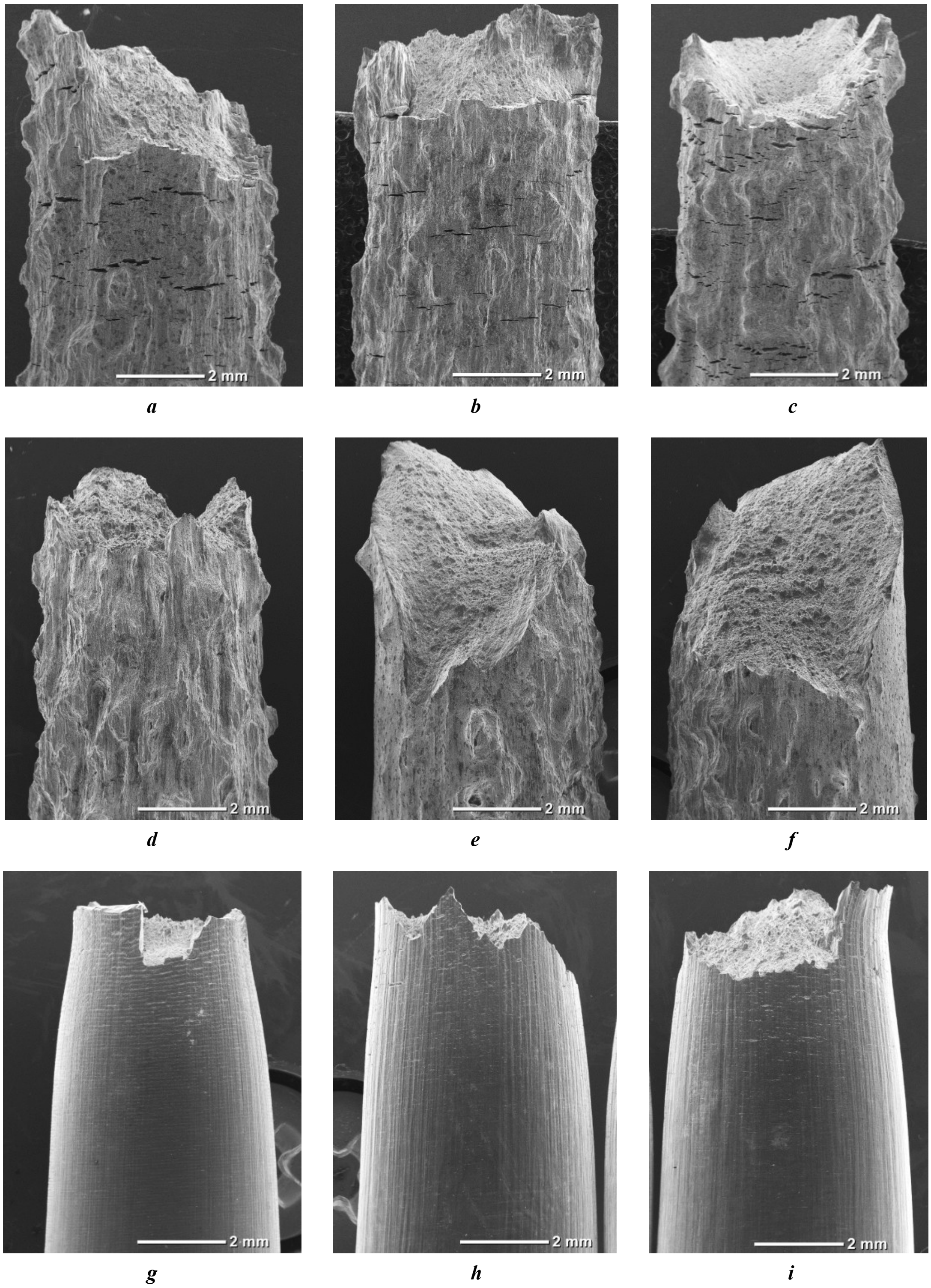

Fig. 4. *The effect of strain rate (**a**, **d**, **g** – 5·10^{-6} s^{-1}; **b**, **e**, **h** – 5·10^{-5} s^{-1}; **c**, **f**, **i** – 5·10^{-4} s^{-1})*
on the state of the side surface of the specimens tensile-tested in air:
***a**–**c** – after pre-exposure to the corrosive medium;*
***d**–**f** – after pre-exposure to the corrosive medium and removal of corrosion products;*
***g**–**i** – in the reference state. SEM*

Рис. 4. *Влияние скорости деформирования (**a**, **d**, **g** – 5·10^{-6} с$^{-1}$; **b**, **e**, **h** – 5·10^{-5} с$^{-1}$; **c**, **f**, **i** – 5·10^{-4} с$^{-1}$)*
на состояние боковой поверхности образцов, испытанных на растяжение на воздухе:
***a**–**c** – после выдержки в коррозионной среде;*
***d**–**f** – после выдержки в коррозионной среде и удаления продуктов коррозии;*
***g**–**i** – в исходном состоянии. СЭМ*

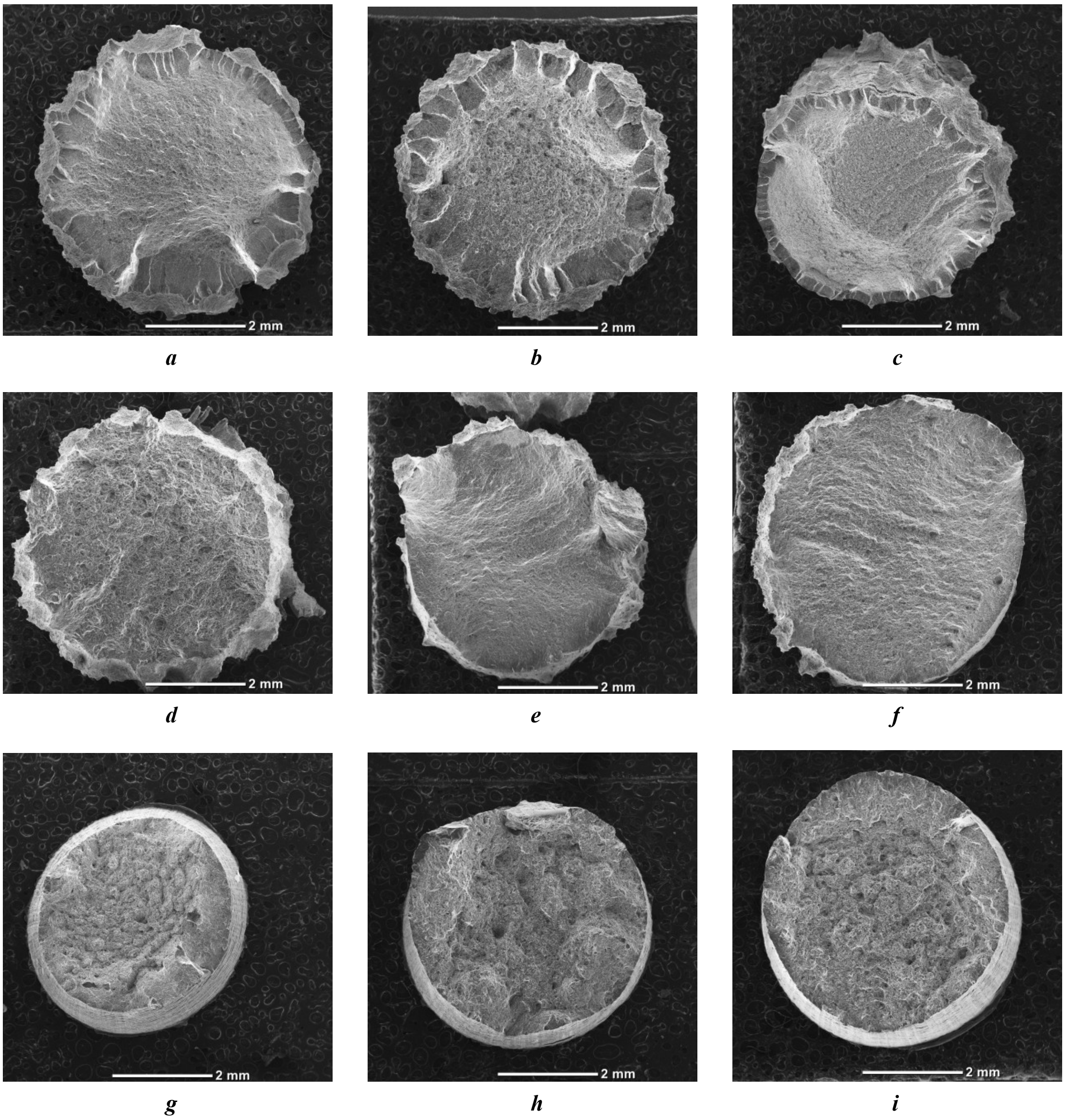

Fig. 5. *The effect of strain rate (**a**, **d**, **g** – $5\cdot10^{-6}$ s^{-1}; **b**, **e**, **h** – $5\cdot10^{-5}$ s^{-1}; **c**, **f**, **i** – $5\cdot10^{-4}$ s^{-1}) on the state of the fracture surface of the specimens tensile-tested in air:*
__a__–__c__ – after pre-exposure to the corrosive medium;
__d__–__f__ – after pre-exposure to the corrosive medium and removal of corrosion products;
__g__–__i__ – in the reference state. SEM

Рис. 5. *Влияние скорости деформирования (**a**, **d**, **g** – $5\cdot10^{-6}$ $с^{-1}$; **b**, **e**, **h** – $5\cdot10^{-5}$ $с^{-1}$; **c**, **f**, **i** – $5\cdot10^{-4}$ $с^{-1}$) на состояние излома образцов, испытанных на растяжение на воздухе:*
__a__–__c__ – после выдержки в коррозионной среде;
__d__–__f__ – после выдержки в коррозионной среде и удаления продуктов коррозии;
__g__–__i__ – в исходном состоянии. СЭМ

of the specimens in the initial state, due to which an increase in the loss of ductility occurred. However, as the results of this work show, in the case of soaking for 12 h with an increase in the strain rate, the ductility of the specimens with the removed corrosion products remains practically unchanged.

It might be supposed that the difference in the rate sensitivity of the ductility of the reference and pre-exposed specimens with the removed corrosion products can be associated with irreversible corrosion damage, the degree of which in the case of soaking for 12 h is significantly higher than after soaking for 1.5 h. Thus, the work [23] shows that the surface roughness and the decrease in the cross section of the ZK60 alloy specimens resulting from corrosion after 12 h soaking in a 4 % NaCl + 4 % $K_2Cr_2O_7$ solution were 4 times higher than after 1.5 h.

A decrease in the cross section of the specimens resulting from keeping in the medium leads to a decrease in the load of yielding and the maximum load to fracture, which results in an apparent decrease in the yield and ultimate tensile strength. A surface roughness increase associated with the occurrence of numerous deep corrosion pits, probably, greatly facilitates the initiation of cracks, which mainly affects the ductility of the specimens. The results of the analysis of tensile diagrams showed that the drop of ductility resulting from 12 h exposure to a corrosive environment occurs primarily due to a great reduction in the length of the localized deformation part δ_l, which, unlike δ_{SH}, is not recovered after the corrosion products removal. It is well known that the formation of ductile cracks in metallic materials occurs due to the coalescence of voids appearing during tension of smooth specimens after the significant plastic deformation at the stage of localized flow in the neck area [26]. Apparently, in specimens subjected to the exposure to a corrosive medium, ductile cracks are formed due to the merging of corrosion pits; therefore, plastic deformation is not needed for the formation of voids, and fracture occurs soon after the deformation is localized in the neck.

According to the results of this work, a decrease in the elongation of the reference specimens with an increase in the strain rate occurs as well mainly due to a decrease in δ_l. Consequently, an increase in the strain rate does not affect the elongation of the specimens with the removed corrosion products, since their δ_l has already been reduced almost to a minimum due to severe corrosion damage. It should be mentioned that after the removal of corrosion products from the specimens, which were kept in a corrosive environment for 1.5 h and, thus, had much weaker corrosive damage, both δ_l and δ_{SH} were completely restored; therefore, an increase in the strain rate in this case led to a decrease in elongation as it was with the specimens in the reference state.

The results obtained indicate that the presence of a negative strain rate dependence of the ductility loss during PESCC of magnesium alloys is not always an unambiguous indicator of the diffusible hydrogen participation in the fracture mechanism.

According to the results of this study, in addition to a decrease in ductility with an increase in the strain rate, there is an increase in the strength of the specimens both in the initial state and after soaking and corrosion products removal. However, the strength of specimens kept in a corrosive medium grows much weaker with an increase in the strain rate than that of the specimens in the reference state. For this reason, the strength loss of specimens kept in a corrosive medium increases with an increase in the strain rate.

Differences in the rate sensitivity of strength of the specimens in the reference state and specimens kept in a corrosive environment can presumably be associated with corrosion damage as well. Probably, with an increase in the strain rate, the alloy becomes more sensitive to stress risers which are corrosion pits. At a low strain rate, they have enough time to become plastically blunt, which is accompanied by the stress relaxation near the stress risers, while at a high strain rate, the same pits remain relatively sharp, and therefore, the local fracture stress near them is achieved at a lower external stress.

Thus, on the one hand, an increase in the strain rate leads to an increase in the ultimate strength due to the difficulty of plastic deformation in the entire volume of the specimen. On the other hand, the local hindrance of plastic deformation near the stress risers prevents their blunting and, as a result, leads to a decrease in the ultimate tensile strength. Since the specimens in the reference state do not have large stress risers, their effect on the ultimate tensile strength is insignificant, and it greatly increases with an increase in the strain rate. In addition, with the increasing strain rate of the specimens kept in a corrosive medium, a decrease in the ultimate tensile strength associated with an increase in the sharpness of stress risers compensates for the increase in the ultimate tensile strength from the hindrance of plastic deformation over the bulk of the specimen as a whole.

MAIN RESULTS AND CONCLUSIONS

1. An increase in the degree of corrosion damage on the surface of the ZK60 alloy specimens resulting from an increase in the duration of their preliminary exposure to a corrosive environment can lead to a fundamental change in the strain rate sensitivity of the mechanical properties of these specimens during subsequent tests in air.
2. A decrease in the ZK60 alloy elongation with an increase in the strain rate occurs mainly due to a reduction of the localized deformation stage.
3. The formation of deep pits and other corrosion damages leads to a reduction of the length of the localized deformation part of the stress-strain diagram and does not affect the length of the strain hardening region.
4. With an increase in the strain rate, the elongation of specimens with a high degree of corrosion damage practically does not change, and the loss of their ductility with respect to the specimens not subjected to corrosion increases, since the localized deformation stage in the specimens damaged by corrosion is virtually absent.
5. The negative strain rate dependence of the ductility loss of the specimens, from the surface of which the corrosion products were removed after a long exposure to a corrosive medium, is associated with a high degree of corrosion damage to their surface and not with the presence of hydrogen in their bulk.

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Скоростная чувствительность механических свойств сплава ZK60 с высокой степенью коррозионных повреждений

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Аннотация: Существует устойчивое мнение, что водород, поглощаемый магниевыми сплавами в процессе коррозии, может вызывать их коррозионное растрескивание под напряжением. Одним из характерных признаков участия диффузионно-подвижного водорода в механизме разрушения металлов является отрицательная скоростная зависимость степени охрупчивания. В недавних исследованиях было показано, что потеря пластичности образцов сплава ZK60, подвергнутых кратковременному (1,5 ч) воздействию коррозионной среды, действительно уменьшается с ростом скорости деформации. Однако после удаления продуктов коррозии с поверхности образцов скоростная зависимость потери пластичности становится положительной, что свидетельствует об отсутствии водорода в объеме металла. При кратковременной выдержке в коррозионной среде глубокое проникновение водорода в металл могло быть ограничено недостаточным для диффузии водорода временем. В работе исследовано механическое поведение сплава ZK60, подвергнутого более длительной (12 ч) предварительной выдержке в коррозионной среде с последующим испытанием на растяжение в атмосфере воздуха при различных скоростях деформации. Рассмотрено влияние скорости деформирования, длительной выдержки в коррозионной среде и последующего удаления продуктов коррозии на прочность, пластичность, стадии деформационного упрочнения и локализованной деформации, а также на состояние боковой поверхности и изломов образцов. Установлено, что потеря пластичности образцов, выдержанных в течение 12 ч в коррозионной среде, уменьшается с ростом скорости деформирования независимо от того, были удалены продукты коррозии с их поверхности или нет. Показано, что в данном случае отрицательная скоростная зависимость потери пластичности связана не с водородом, растворенным в объеме металла, а с наличием глубоких коррозионных повреждений поверхности образцов. Предложено объяснение влияния коррозионных повреждений на механические свойства и чувствительность этих свойств к изменению скорости деформации.

Ключевые слова: магниевые сплавы; сплав ZK60; коррозионное растрескивание под напряжением; коррозия; скорость деформации; механические свойства.

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