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DEVELOPMENT AND APPROVAL OF THE PROCEDURE OF HIGH-TEMPERATURE UNIAXIAL CREEP STRENGTH TESTS OF DIFFICULT-TO-WELD HIGH-TEMPERATURE NICKEL ALLOYS SPECIMENS WITH MICROPLASMA POWDER DEPOSITION

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ABSTRACT

The procedure of high-temperature uniaxial creep testing of welded joints "base-deposited metal" made of difficult-to-weld high-temperature nickel alloys (HTNA) of ZhS32 type, containing more than 60 vol.% of the strengthening γ′-phase, has been developed. It allows using witness specimens to estimate the uniaxial creep strength level at temperatures of 975 and 1000 °C for the conditions of series restoration of edges of the working blades of modern aircraft gas turbine engines with microplasma powder deposition. Its development took into account the need in working with larger sizes and, accordingly, the higher restraint of a welded workpiece for the manufacture of specimens for mechanical tests compared to the typical conditions of series restoration of the blade edge in industry, and also some techniques for hot cracks prevention were proposed. Its feature is the use of "dovetail" type grippers for specimens with a working part of 7.5–9.0 mm^2, which provides a significant reduction in their sizes. The new approach of choosing the shape and dimensions of the specimen for uniaxial creep testing, the technique of preparing and forming the required welded workpieces with microplasma powder deposition allows a significant reduction in heat input and approximation of the deposition modes for witness specimens to the industrial modes of series restoration of edges of working blades of aircraft gas turbine engines. Due to this, in the welded joints "base-deposited metal" of the high-temperature nickel alloys with directional solidification, which represent workpieces for the subsequent production of such witness specimens, it is possible to avoid the known manifestations of the tendency to crack formation during the deposition process and postweld heat treatment. The developed procedure was approved to evaluate the uniaxial creep strength of ZhS32 deposited metal specimens and specimens "50 % of base (ZhS26-VI or Zh32-VI) + 50 % of deposited (ZhS32) metal" at 975 °C and 1000 °C on 40 h base holding and comparison of the relevant experimental data with the technical condition requirements for these cast nickel-based superalloys was carried out.

KEYWORDS: microplasma powder deposition, welded joint "base-deposited metal", difficult-to-weld high-temperature nickel alloys, uniaxial creep testing

INTRODUCTION

In our country, working blades of difficult-to-weld high-temperature nickel alloys (HTNA) ZhS26 and ZhS32 (Table 1), designed for operation in modern aircraft gas turbine engines (GTE) for operating temperatures 950–1100 °C are manufactured in large volumes and remain in operation. At domestic aircraft repair enterprises, series technologies for the restoration of shrouded and unshrouded blades on the base of the process of microplasma powder deposition [1–4] with the use of a filler material of equivalent level of alloying were mastered. Evaluation of the mechanical properties of such welded joints "base-deposited metal", compensating for the losses of damaged material of parts in the local zones of a shroud platform or an airfoil edge (Figure 1), remains to be the relevant task. In particular, this applies to one of the most important indices of such materials — uniaxial creep strength at 975 and 1000 °C [5, 6]. Simultaneous combination of two adverse factors — larger sizes and, accordingly, higher restraint of a welded workpiece compared to the typical conditions for restoration of a blade edge in industry and the known high tendency to crack formation in fusion welding of HTNA with a high content of the strengthening γ′-phase require individual approaches for evaluation of high-temperature creep strength of these welded joints. Similar publications of other authors during the preparation of this article were not found.

The review of the known standards for mechanical tests [7, 8] and their analysis [9] show that they regulate the parameters of the working area of the specimen, and the guidelines on the shape and sizes of its gripping part bear only recommended nature. The consumption of the material to manufacture the specimen for mechanical tests depends on its geometric dimensions (length of the working area and overall dimensions of the gripping part), and also on the required tolerances on its mechanical treatment. But regardless of the type of the specimen for mechanical testing (flat, cylindrical), it can be stated that the need in forming its gripping part during the manufacture significantly increases the overall dimensions of both directly the specimen as well as the corresponding resulting workpiece.

Table 1. Content of base alloying elements in high-temperature nickel alloys

Alloy	wt.%					
	C	Cr	Ni	Co	Al	Ti
ZhS26-VI	0.12–0.18	4.3–5.3	Base	8.7–9.3	5.6–6.1	0.8–1.2
ZhS32-VI	0.12–0.17	4.3–5.3		9.0–9.5	5.7–6.2	–
VZhL12U	0.14–0.19	9.0–10.0		13.5–14.5	5.1–5.7	4.2–4.7
ChS40	≤ 0.05	19.0–21.0		–	2.4–2.7	–

Table 1. Cont.

Alloy	wt.%							
	Mo	W	Nb	Ta	Re	V	Fe	Si, Mn
ZhS26-VI	0.8–1.4	10.9–12.5	1.4–1.8	–	–	0.8–1.2	≤ 0.5	≤ 0.3
ZhS32-VI	0.9–1.3	8.1–8.9	1.4–1.8	3.7–4.7	3.6–4.3	–	≤ 0.5	≤ 0.2
VZhL12U	2.7–3.4	1.0–1.8	0.5–1.0	–	–	0.5–1.0	≤ 1.0	≤ 0.2
ChS40	8.0–10.0	4.5–5.5	–	–	–	–	≤ 5.0	≤ 0.3

The main problems that significantly complicate the use of standard procedures for the preparation of welded workpieces and manufacturing of specimens from them for the welded joint "base-deposited metal" of HTNA, which simulates the conditions for restoration of working blades of aircraft GTE, are the following:

● Limited deformation capacity of the deposited metal of HTNA with a content of the strengthening γ′-phase of more than 50 vol.% in a state directly after surfacing (for example, according to [10–12] $\varepsilon_{1000\,°C} \leq \leq 0.7$ %) and a high tendency of the cast base metal to the formation of cracks in fusion welding. This, in turn, prevents the performance of a defect-free deposition with a volume of more than 2–3 cm^3 [12] by an increase in the number of heat inputs into the product due to the components of efficient thermal power of the arc and heat input [13, 14].

● High cost of base metal workpieces and specialized HTNA filler materials, need in their manufacturing by an individual order.

● Complicated mechanical treatment ability of HTNA [15].

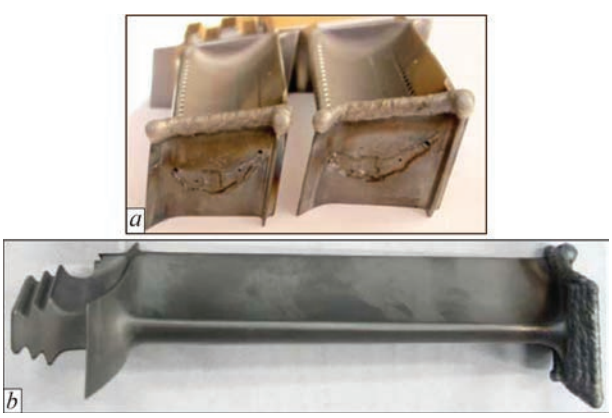


Figure 1. Appearance of restored shrouded working blades of modern aircraft GTE [3]: *a* – working blades of high-pressure turbine, ZhS32-VI alloy; *b* — working blades of medium-pressure turbine, ZhS26-VI alloy

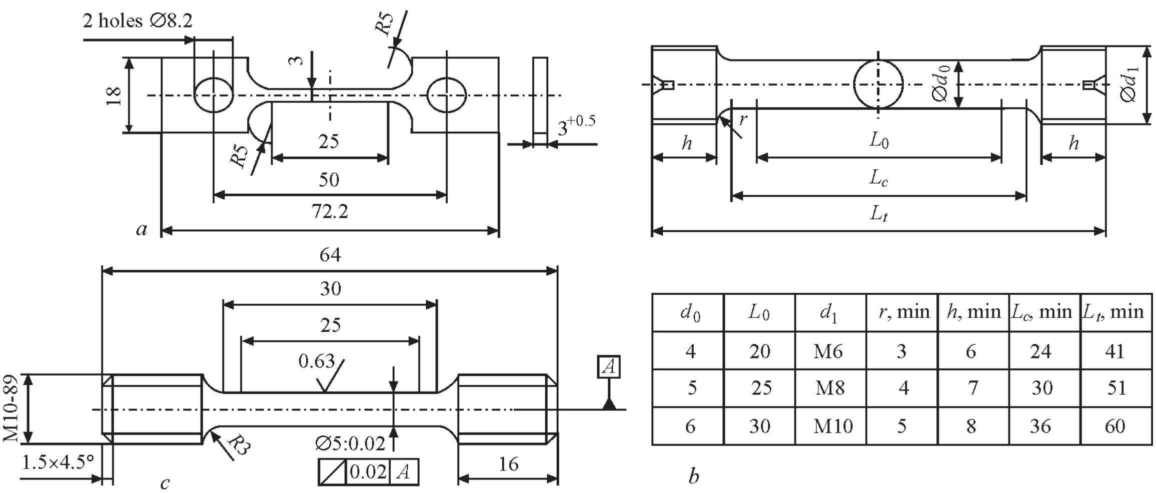
THE AIM

of the work is to develop a procedure of high-temperature tests on uniaxial creep strength of specimens with microplasma powder deposition of working blades of GTE aircraft blades made of difficult-to-weld HTNA.

The preliminary positive experience of using miniature flat proportional specimens for tensile tests at high temperature in the MTS-810 servohydraulic machine at the PWI [9] has been gained. It consist in a significant reduction of the overall dimensions of the gripping part of the flat specimen for mechanical testing, and accordingly the volume required for its manufacture of welded workpiece from HTNA due to the use of "dovetail" type grippers-adapters. In turn, the releavant tasks in the framework of development of a new testing procedure for high-temperature creep strength were the development of a typical specimen and grippers-adapters for the MP-3G test machine, as well as shape, sizes, modes of deposition of initial welded workpiece, which guarantees its producing without crack formation.

DEVELOPMENT OF RESEARCH METHODS

During the preliminary analysis, 3 types of specimens were selected for high-temperature strength tests as initial prototypes. From the flat specimen, which is used at the PWI [16] and has a gripping part with holes under a pin of 8 mm diameter, the shape of the working area was borrowed (25 mm length, 7.5–9.0 mm^2 calculated cross-section, Figure 2, *a*). To specify the necessary geometric characteristics of the gripping part, the following cylindrical prototype specimens were analyzed: with a diameter of 4×M6, 5×M8 and 6×M10 according to ISO 6892-2:2011 [7] (Figure 2, *b*); close to the specimen MI-83 [16] (Figure 2, *c*), which, as is known, is serially used for tests of HTNA VZhL12U and ZhS6U on a high-temperature creep strength. On these specimens, on the base [17], the geometric characteristics of surfaces (Figure 2, *b*) were identified, which in the threaded connection resist to the most dangerous shear [18] and crumpling forces: an area of resistance to shear forces S_{sh} and the equivalent material volume V_Σ of a



d_0	L_0	d_1	r, min	h, min	L_c, min	L_t, min
4	20	M6	3	6	24	41
5	25	M8	4	7	30	51
6	30	M10	5	8	36	60

Figure 2. Prototype specimens used to design an optimized flat proportional miniature specimen for the task of testing welded joint "base-deposited metal" of HTNA on high-temperature creep strength: *a* — flat proportional specimen of the PWI; *b* — cylindrical specimen according to ISO 6892-2:2011 [7]; *c* — cylindrical specimen for testing HTNA VZhL12U and ZhS6U

gripping part of the specimen (Table 2), which resists to crumpling. Based on the known principles of the theory of similarity [19], the determined indices of metric threads M6 and M8, were converted into the required dimensions of the gripped part of the flat "dovetail" type specimens (Figures 3, 4). Further, for the MP-3G test machine, a set of the specialized fixture made of HTNA VZhL12U with holes under a pin with a diameter of 6 mm was manufactured (Figure 5), which involves the use of the intermediate gripper-adapter to mount flat specimens with a gripped part of the "dovetail" type.

In addition to the performed verification calculations of shear and crumpling strength of a gripping part of the proposed specimen (see Figure 4, *a*), its serviceablility was checked by simulating the static loading process at a temperature of 1000 °C in the SOLIDWORKS Simulation 2015 software package of the corresponding 3D models of a new and a standard specimen with a diameter of 4×M6 (Figure 5). In this case, reference data from the mechanical characteristics of the material of the cast HTNA ZhS32-VI were used according to [20]. The results of physical modeling showed that in the proposed flat specimen (see Figure 6, *a*, *b*), a set level of stresses of 150 and 200 MPa is directly implemented on its working area and is identical to the standard specimen with a diameter of 4×M6 (see Figure 5, *c*, *d*). In places of transition to the gripping part, the concentration of high stresses is not observed.

Checking the manufactured set of a fixture for high-temperature testing of welded joints of difficult-to-weld high-temperature nickel alloys for creep strength was carried out in several stages with a gradual increase in the test temperature and the level of the material heat resistance. At the first stage, for the mentioned tests by multilayered deposition, the "ver-

Table 2. Ratio of basic geometric parameters of cylindrical specimens with a diameter of 6×M10, 5×M8 and 4×M6 according to ISO 6892-2:2011 with the results of calculations of equivalent geometric characteristics for flat proportional specimens: S_0 — cross-sectional area of the working zone of the specimen; S_{sh} — area of the thread, which resists to the shear force in the gripper; V_Σ — equivalent material volume that resists to the buckling and shear force in the gripper (in the thread or flat proportional specimen)

Cylindrical specimen								Flat proportional specimen	
Type	S_0, mm²	Thread pitch P, mm	Average thread diameter d_2, mm	Inner thread diameter d_1, mm	Number of turns z, pcs	S_{sh}, mm²	V_Σ, mm³	According to Figure 4, *a*, S_0 = 9 mm²	According to Figure 4, *b*, S_0 = 18 mm²
								V_Σ, mm³	
Diameter 4×M6	12.56	1	5.35	4.92	12	154.47	69.87	74.0	–
						77.35*	34.93*	37.00*	–
Diameter 5×M8	19.63	1.25	7.188	6.65	9	208.82	110.01	–	110.00
						104.41*	55.00*	–	55.00*
Diameter 6×M10	28.26	1.5	9.026	8.38	8	263.14	176.81	–	–
						131.57*	88.41*	–	–
*For half of the volume of the threaded connection or gripper of the "dovetail" type.									

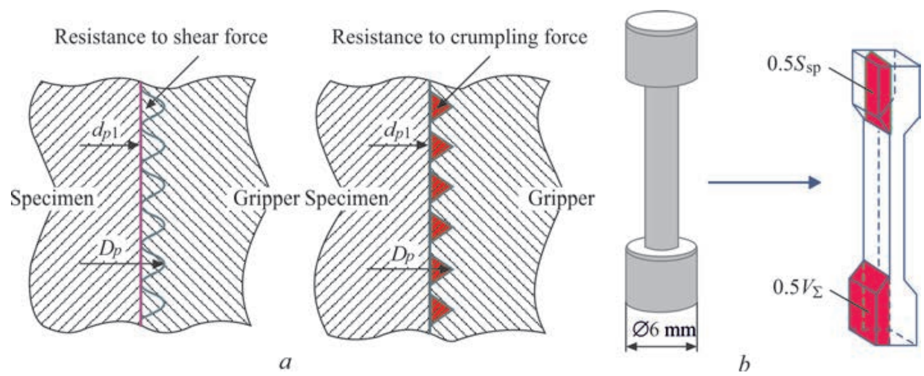


Figure 3. Equivalent surfaces of resistance to shear and crumpling force for the threaded connection of the prototype specimen (*a*) and the scheme of their conversion into the gripping part of the optimized flat proportional specimen of the "dovetail" system (*b*)

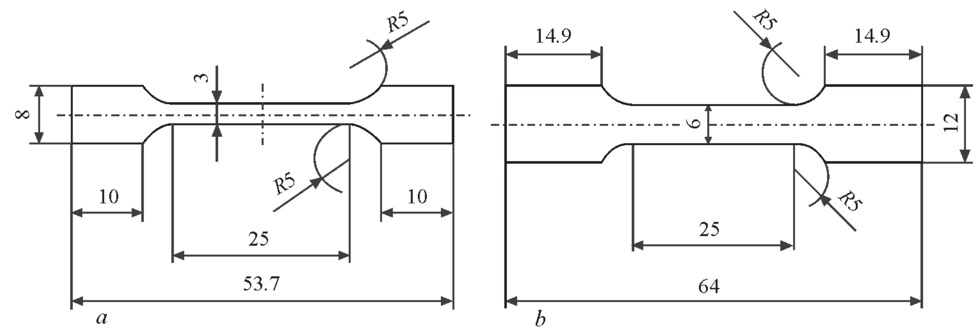


Figure 4. Drawings of designed optimized miniature flat proportional specimens with the gripper of the "dovetail" type for tests on high-temperature creep strength: *a* — with the cross-sectional area of its working part S_0 = 9 mm²; *b* — with the cross-sectional area of its working part of S_0 = 18 mm²

tical wall" workpiece was manufactured, from which after grinding of its side surfaces, the optimized flat proportional specimens were cut out by means of the electrical discharge machining (Figure 7). At the second stage, the preparation of the welded workpiece "50 % of base + 50 % of deposited metal" was practiced, from which the optimized flat proportional specimens were similarly cut out (Figures 8, 9).

RESULTS OF EXPERIMENTS AND THEIR ANALYSIS

The conditions and results of testing the deposited ChS40 metal, layered deposited ZhS32 + ChS40 metal, formed respectively to [21], and deposited ZhS32 metal are presented in Table 3 (experiments Nos 1–3). They proved the proper operation of the manufactured set of the specialized fixture for the test MP-3G machine: at T = 550 °C and σ = 69 kgf/mm² — holding of at least 120 h; at T = 975 °C and σ = 7.5–10.0 kgf/mm² — holding of approximately 20 h. The next stage of the research works was practicing the shape and sizes of the welded workpiece for the welded joint "50 % of base + 50 % of deposited metal".

When using a conventional deposition of ZhS32 alloy to the edge of the plate from the cast HTNA ZhS32-VI or ZhS26-VI to form a gripping part of a flat proportional specimen according to Figure 4, *a*, it is necessary to use a single-layer deposition with the

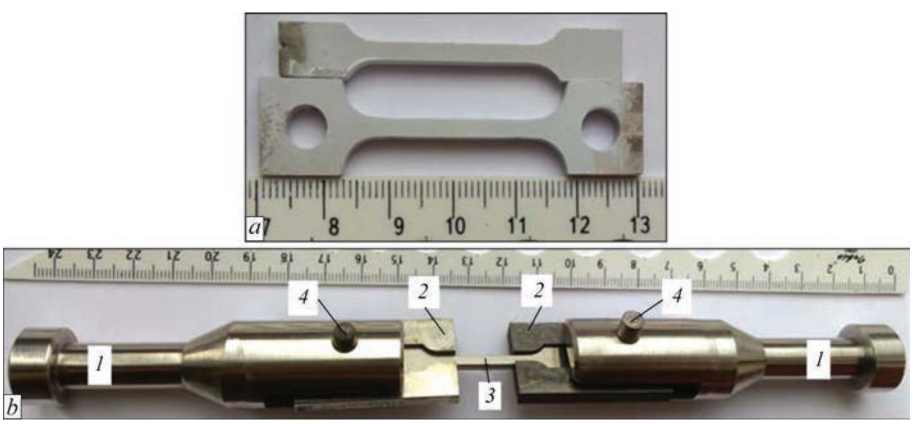


Figure 5. Appearance of the optimized flat proportional specimen compared to the specimen of a conventional shape (*a*) and manufactured assembly of a specialized fixture for the test MP-3G machine (*b*). Designations: *1* — main gripper; *2* — intermediate gripper-adapter; *3* — specimen for mechanical testing; *4* — pin of 6 mm diameter

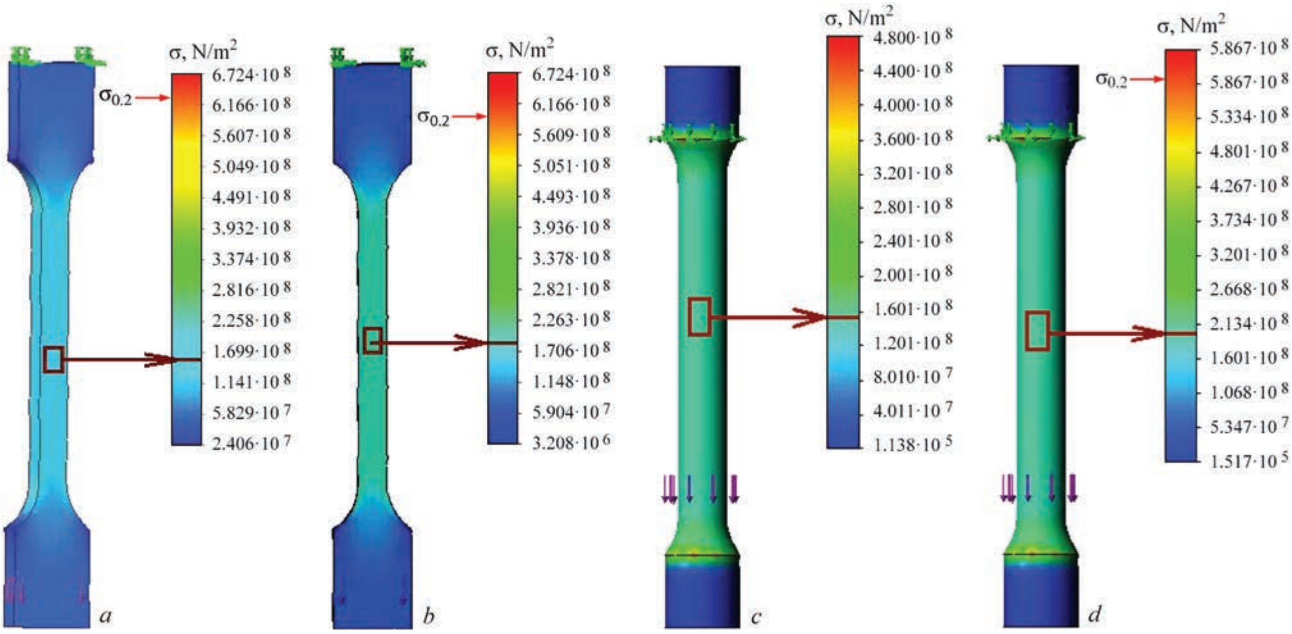


Figure 6. Results of physical simulation of 3D models of a new specimen (*a, b*) and a specimen with a diameter of 4×M6 (*c, d*) from the cast HTNA ZhS32-VI alloy at 1000 °C in the software SOLIDWORKS Simulation 2015 package

bead height of 6–7 mm on the side of the deposited metal (Figure 8, *a*, *b*). However, it turned out that such modes of microplasma powder deposition on the edge of the plate with a thickness of 3.5–5.0 mm, which are characterized by the actual welding current value I = 25–35 A, effective heat power q_s/v = 350–450 W and input power q_s/v = 2000–3000 J/mm, cause the formation of regular cracks (Figure 8, *c*, *d*). According to the data of metallographic testing of 10 sections, they are localized in the deposited metal. Their appearance is explained by the occurrence of tensile deformations in the process of deposition, that exceed the preliminary set limited deformation capacity of the deposited ZhS32 metal [11]. In turn, in view of the preliminary set direct proportionality between the value of the input heat and cross-section of the deposited bead in microplasma powder deposition [14], their appearance may be caused by an increase in the heat input to the product [13] within a longer time of welding pool existence during formation of a bead with a height of 6–7 mm by single-layer deposition.

At the same time, the preliminary formation of the depression on the edge surface of the plate made of HTNA along the shape of the working part profile of the flat proportional specimen (see Figure 4, *a*, *b*) allows ensuring the formation of a gripping part on the side of the deposited metal at a height of the deposited bead reduced to 3–4 mm. Such modes of deposition compared to the first variant are characterized by the heat input q_s/v = = 1000–1500 J/mm, which is accordingly explained by the formation of a much smaller cross-section of the deposited bead [14]. The next heat treatment of such welded workpiece by the modes of aging 1050 °C — 2.5 h and homogenization (1265 °C — 1.5 h for the base metal of ZhS26-VI alloy or 1280 °C — 1.5 h for the base metal of ZhS32-VI alloy) did not reveal any manifestations of the tendency to cracking in it according to the results of liquid penetrant testing and metallographic testing. A typical example of a high-quality microstructure of the base and deposited metal in the fusion line area is presented in Figure 10. After manufacturing specimens for testing on creep strength by means of the electrical discharge machining, the neighborhood of the fusion line between the base and deposited ZhS32 metal was quite evenly distributed in the middle of its working area.

According to the practiced procedure (see Figure 4, *a*, *b*), microplasma powder surfacing of 3 welded workpieces "50 % of base + 50 % of deposited metal" with ZhS32 alloy was performed and after passing of the appointed heat treatment, additional grinding, polishing of electro-erosion cutter surfaces and capillary testing, the specimens were tested for high-temperature creep strength at 975 and 1000 °C.

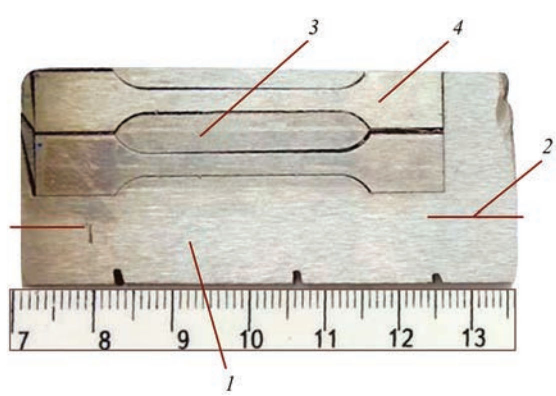


Figure 7. Scheme of producing an optimized flat proportional specimen of deposited metal for high-temperature tests of the deposited metal: *1* — technological base of austenitic stainless steel; *2* — position of the fusion line with the deposited metal; *3* — deposited metal of heat-resistant or high-temperature alloy; *4* — optimized flat proportional specimen

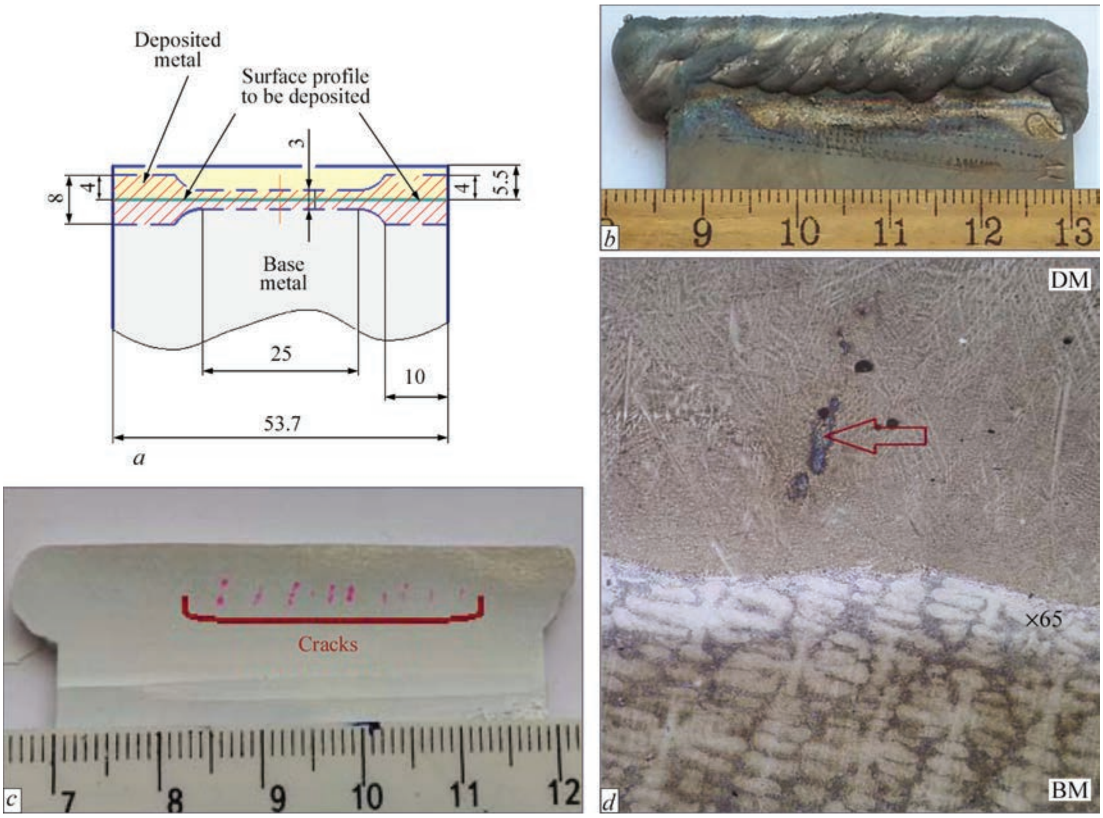


Figure 8. Regularities of crack formation in the welded joint "50 % of base (BM) + 50 % of deposited (DM) metal" made of HTNA of ZhS32 type produced by a single-layer microplasma powder deposition of ZhS32 alloy with q_s/v = 380–450 W and q_s/v = = 2000–3000 J/mm: *a* — scheme of preparation of welded workpiece and cutting of the specimen for mechanical testing; *b* — appearance of a single-layer deposition; *c* — results of liquid penetrant testing after removal of the side reinforcements of the deposited bead; *d* — appearance of cracks in the deposited ZhS32 metal detected during metallographic testing

The test results are presented in Table 3 (experiments Nos 4–6). Their interpretation taking into account the experimental data previously obtained at the PWI [2] and the basic requirements for the minimum level of mechanical properties of the cast HTNA ZhS32-VI and ZhS26-VI according to TS 1-92-177–91 published in [6, 7], is given in Figure 11.

The experimental data of tests of the specimens "50 % of base + 50 % of deposited metal" on creep strength with the participation of the deposited ZhS32 metal, cut out along the fusion line with the cast ZhS26-VI or ZhS32-VI alloy, exhibit that the indices for the basic 40 h creep strength relative to the level of relevant requirements in the acting TS on the cast ZhS32-VI or ZhS26-VI alloys [6, 7], are the following:

- for the specimen "50 % of base (ZhS32-VI) + 50 % of deposited (ZhS32) metal" after heat treatment by aging mode 1050 °C — 2.5 h — approximately 0.5 at 1000 °C;

Table 3. Results of tests on uniaxial creep strength of specimens of welded joints with microplasma powder deposition

Experiment number	Specimen description	Specimen type	Preliminary heat treatment of the specimen	T, °C	Load σ, kgf/mm²	Holding time τ, h and min
1	DM of ChS40	According to Figure 4, *a*	1050 °C — 2.5 h + 760 °C — 10 h + 650 °C – 25 h	550	69.0	120 h*
2	DM of ZhS32 + ChS40 (L)	According to Figure 4, *b*	1050 °C — 2.5 h	975	7.5	17 h 25 min**
3	DM of ZhS32	According to Figure 4, *a*	1050 °C — 2.5 h	975	10.0	10 h**
4	50 % BM of ZhS32-VI + + 50 % DM of ZhS32		1050 °C — 2.5 h	1000	14.5	60 h**
5	50 % BM of ZhS32-VI + + 50 % DM of ZhS32		1280 °C — 1.5 h	975	20.0	23 h 30 min**
6	50 % BM of ZhS26-VI + + 50 % DM of ZhS32		1265 °C — 1.5 h	975	20.0	44 h**

*The specimen was removed without fracture.
**Fracture of the specimen occurs over its working part.

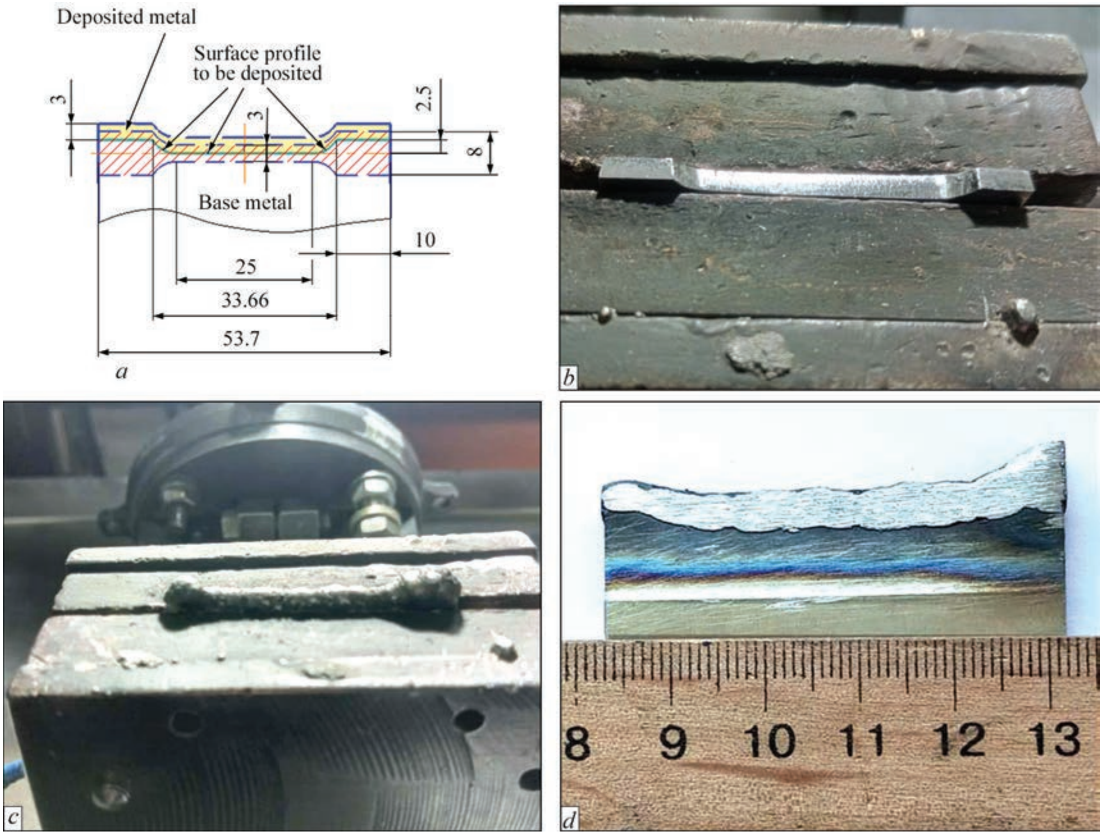


Figure 9. Features of surface preparation and technique of surfacing welded workpiece for welded joint "50 % of base — 50 % of deposited metal" made of HTNA: *a* — scheme of preparation of welded workpiece and cutting of the specimen for mechanical testing; *b* — preliminary formation of depression before deposition; *c* — appearance of a single-layer deposit; *d* — welded workpiece after partial removal of side reinforcements of deposited bead

● for the specimen "50 % of base (ZhS32-VI) + 50 % of deposited (ZhS32) metal" after heat treatment by homogenization mode 1280 °C — 1.5 h — approximately 0.6 at 975 °C;

● for specimen "50 % of base (ZhS26-VI) + 50 % of deposited (ZhS32) metal" after heat treatment by homogenization mode 1265 °C — 1.5 h — approximately 0.77 at 975 °C.

Thus, it was established that the welded joint "base-deposited metal" with the height of the deposited layer of ZhS32 alloy of up to 3 mm in the zone of the fusion line has sufficiently high indices of the creep strength — at a level of 0.5–0.6 at temperatures of 975 and 1000 °C relative to the minimum requirements for the cast ZhS32-VI alloy; at a level of 0.77 at a temperature of 975 °C for the cast ZhS26-VI alloy. For the serviceability of the restored sealing elements of working blades of high- and medium-pressure turbines (edges of shroud platforms and upper edge of the airfoil) made of HTNA ZhS32-VI and ZhS26-VI alloys, a sufficient

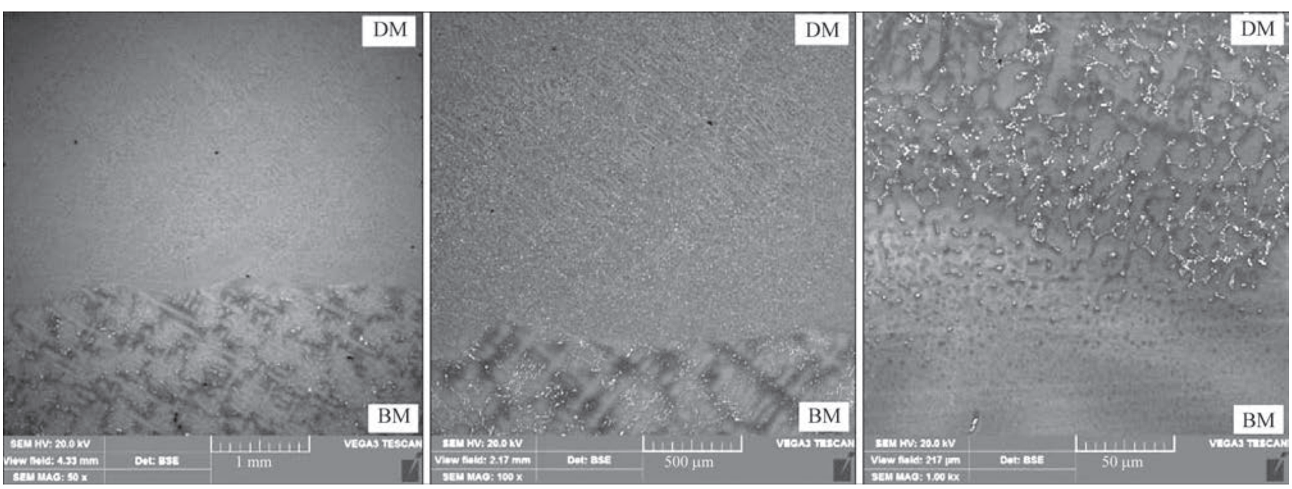


Figure 10. Typical example of a high-quality microstructure of welded joint "50 % of base (BM) +50 % of deposited (DM) metal of ZhS32 alloy

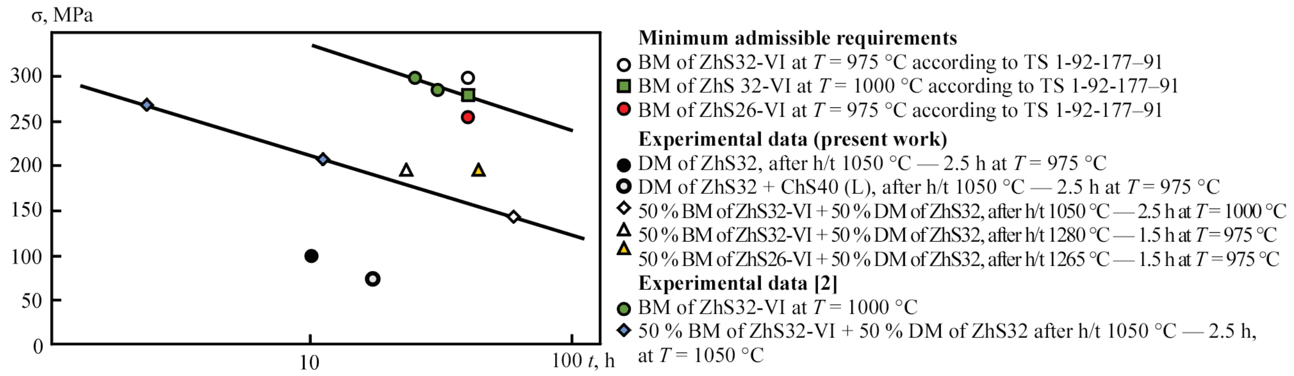


Figure 11. Results of testing specimens of base metal (BM), deposited metal (BM) and "50 % of base (BM) + 50 % of deposited (DM) metal on the creep strength at temperatures of 975 and 1000 °C, produced with microplasma powder deposition of ZhS32 alloy, compared to requirements of acting standard and technical documentation for the cast ZhS32-VI and ZhS26-VI metal

creep strength is achieved at 975 and 1000 °C, which is proved by the practice of long-term operation of the restored working blades on modern aircraft GTE [1–4].

The analysis of the experimental data obtained by the authors of the article and materials of the previously published work [22] allows predicting the presence of a significant decrease in the indices of a high-temperature creep strength, first of all namely for the deposited ZhS32 metal compared to the high-temperature area of the heat-affected-zone of the cast heat-resistant ZhS32-VI and ZhS26-VI alloys. It is assumed that such a decrease in the creep strength of the deposited ZhS32 metal may be predetermined by the excellent conditions of its formation compared to the serial technology of casting HTNA with a directional solidification, in particular, a significant difference (at least by an order [11]) in the cooling rates in the region of the temperature interval of the solidification of ZhS32-VI and ZhS26-VI alloys, which in turn significantly affects the characteristics of the dendritic structure during solidification (see Figure 10), namely the parameter of the distance between the axes of dendrites. Direct causes for reducing the properties of the creep strength namely of the deposited ZhS32 metal at temperatures of 975 and 1000 °C require further research.

CONCLUSIONS

1. The procedure of high-temperature tests for uniaxial creep strength of welded joints "base-deposited metal" made of difficult-to-weld high-temperature nickel alloys of ZhS32 type, based on the use of optimized miniature flat specimens with a cross-section of the working part of 7.5–9.0 mm^2 with a gripping part of the "dovetail" type and intermediate grippers-adaptors has been developed. In this case, under the condition of the same thickness of the welded workpiece, the material consumption compared to a flat prototype specimen is reduced by 2–3 times.

2. For the deposited metal of high-temperature nickel alloys, which has a limited deformation capacity in the process of multilayered deposition, the proposed procedure allows producing specimens without defects and guarantees a high reliability of corresponding experimental data.

3. In order to prevent cracking, during the preparation of a welded workpiece "50 % of base + 50 % of deposited metal" of a high-temperature nickel alloy, it was proposed to preliminary make a sampling-deepening to 2.5–3.0 mm on the edge surface of the plate with a thickness of 3.5–5.0 mm. This allows limiting the height of the deposited bead to 3–4 mm and, by reducing its cross-section and the amount of surfacing material, limiting its heat input to 1000–1500 J/mm at the efficient power of the microplasma arc of 350–450 W by an increse in the rate of microplasma powder deposition.

4. Approval of the developed procedure was carried out when testing the specimens of deposited metal and specimens "base-deposited metal" along the fusion line: at 550 °C — on the base of 100 h; at 975 and 1000 °C — on the base of 40 h.

5. It was established that the welded joint "base-deposited metal" with the participation of the deposited ZhS32 metal, which also includes a high-temperature area of the heat-affected-zone of the base metal, has the following indices of the uniaxial creep strength on the base of 40 h compared to the minimum admissible ones for the cast nickel-based superalloy according to TS: at a level of 0.5–0.6 at temperatures of 975 and 1000 °C relatively to the cast ZhS32-VI alloy; at a level of 0.77 at a temperature of 975 °C relatively to the cast ZhS26-VI alloy.

6. The serviceability of the welded joint "base-deposited metal" made of HTNA of ZhS32type at a level of creep strength determined in the work was proved by the practice of operation during a set interrepair period of a large number of motor sets of working blades of high- and medium-pressure turbines of modern aircraft GTE, restored by the Ukrainian aviation industry since 2005.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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