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WEAR-RESISTANT COATINGS ON THE IRON BASIS, WAS OBTAINED AT NONEQUILIBRIUM CONDITIONS OF ELECTROSPARK METHOD

Встановлено закономірності формування в нерівноважних умовах структури та триботехнічних властивостей електроіскрових покриттів із заевтектичного сплаву на основі заліза, що містить фази впровадження. Внаслідок високої швидкості охолодження покриттів заевтектичний сплав має дуже дисперсну структуру. Обидва компоненти структури досліджених покриттів, містять дисперсні кристали фаз впровадження. Завдяки дисперсній структурі та підвищеному вмісту фаз впровадження заевтектичні покриття мають зносостійкість істотно вище, ніж покриття евтектичного сплаву тієї ж самої системи

Ключові слова: *заевтектичний сплав на основі заліза, фази впровадження, електроіскрові покриття, структура, властивості, висока зносостійкість*

The creation of newest technologies to drawing coatings and a surface processing which are based on use of sources with high energy concentration can be a productive method to improvement of properties both as known and developing alloys. The development of new materials which answer the extraordinary conditions, which inherent in these technologies, opens just more wide opportunities to satisfaction of actual requirements of practical materials technology.

The electrospark method is one of the most wide world methods to deposition coatings with using energy of the electric arc discharge. This method was developed by N.I. Lazarenko [1,2]. It is characterized by high density of power which initiated at the elementary arc discharge on the cathode. As a result of such discharge for a small time interval (0.001sec) in local area of the cathode (100μm) is allocated an energy considerable quantity (about 5 Joule). It leads to a strong overheat of a surface, its intensive evaporation, fusion. Intensive mixing takes place also. Owing to occurrence of the big pressure there is an emission of the fused zone of the cathode in surrounding space, mainly on an opposite electrode. Also on this cathode occurrence the fused zone from which the fused volumes of a material of both electrodes mix up. At disappearance of an electric arc the fused zones very quickly is cooling thanks to intensive heat removal both in a direction of both electrodes, and in surrounding space. The fused zones are cooled with big speeds that essentially influences a structurally-phase condition of substance which is deposited on a substrate.

The basic idea of our work it was to use influence resulted above prominent features of a method electrospark deposition on behavior hypereutectic alloy of a system 12H18N9-TiB_2-CrB_2 [3] for the purpose to studying of structure changes, phase composition and properties which occur at formation of electrospark coatings. It is known that eutectic alloys of metal systems at cooling with different speeds from a liquid state can crystallize according to three mechanisms, and, accordingly, to have three types of structures [4].

At rather small of cooling speeds the mechanism of independent origin from a liquid and independent growth of phases, which consist of eutectic, is realized. The structure, «a rough conglomerate of phases» [5] (fig. 1) is as a result to form.

In the big range of cooling speeds, bigger than in the first case, owing to restriction diffusion mobility of atoms before front crystallization, take place the changing of crystallization

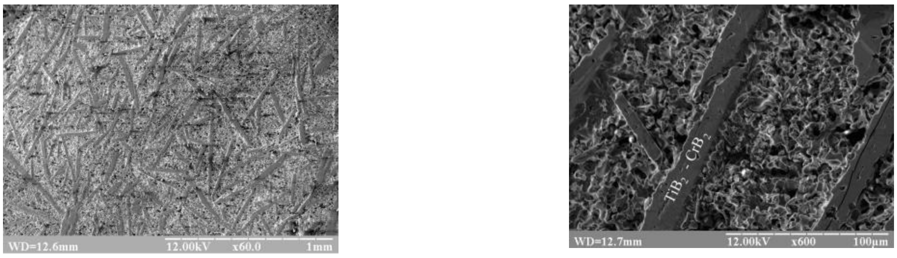
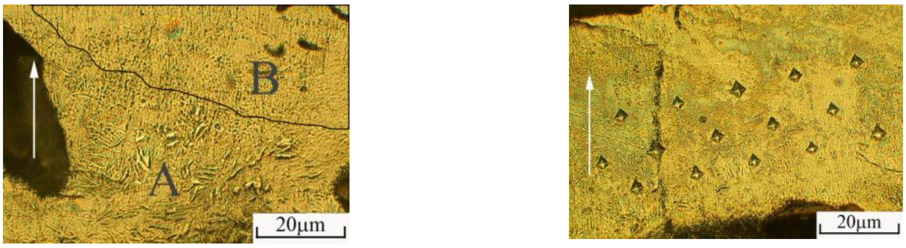


Fig. 1. **The structure of primary cast alloy XTH40 with initial crystals of interstitial phase TiB_2-CrB_2**

a ***b***

Fig. 2. **It is outward an electrospark coating to hypereutectic alloy XTH40. a - a fractures and heterogeneity in coating; *b* - resolutions of rough initial crystals *(A)* in areas with smaller cooling rate**

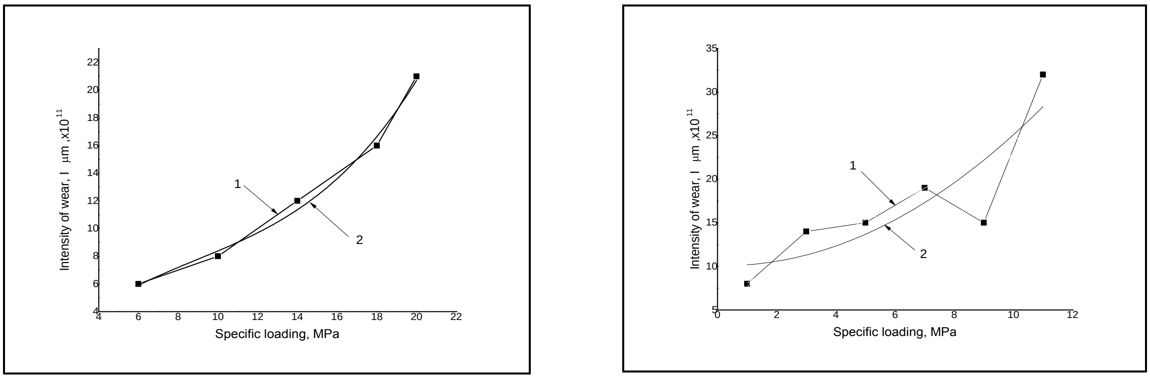


a ***b***

Fig.3. **The structure obtained electrospark coating to hypereutectic alloy XTH 40 *(a)* and measurement of microhardness *(b)*: *A* – the area with colonial structure; *B* – the area with structure of thin conglomerate phases. By arrow the direction of heat rejection is shown: from a surface to depth an alloy**

mechanism. At first in the overcooled liquid there are nucleators of more refractory phase which lead eutectic crystallization. The crystallization front of the second component eutectic follows a leading phase, filling space between the branched to monocrystals of a leading phase. As a result of such co-operative growth the colonial structure is formed. The colonial structure is most extended among known eutectic systems in almost realized ranges of cooling speeds. At the bigger speeds of cooling crystallization occurs again on the mechanism of independent origin and the independent growth, but to essentially smaller crystals of phases. The structure of a thin conglomerate phases is formed. According to the listed three types eutectic structures the properties eutectic alloys essentially differ among themselves owing to the different hardening mechanism.

At electrospark deposition, depending on composition of metal system, there can be conditions at which the third mechanism of crystallisation is realised. At the big speeds of cooling, characteristic for this method, the structure of a thin phases conglomerate is formed. In a case hypereutectic alloy 12X18H9 – 5,5 weight % TiB_2 – 7,5 weight. % CrB_2 [6] (marking XTH40) it is just occurs. On fig. 1 the initial structure of a cast alloy with primary crystals of interstitial phases TiB_2 – CrB_2 and eutectic colonies which settle down between them is resulted. It is well visible that crystallisation of eutectic colonies begins with a surface of primary crystals. According to the N.S. Kurnakov`s rule [7], in hypereutectic alloys mechanical properties should decrease in comparison with eutectic alloy. It occurs thanks to rough structures - to occurrence of primary crystals. But, transitions to structure of a thin conglomerate phases can reduce, at least, speed of properties loss even in hypereutectic alloys. On fig. 2, 3 appearance and structure obtained electrospark coatings to hypereutectic alloy XTH40 are presented. The alloy composition displacement to hypereutectic area provides high dispersion of structure which veils effect decreasing the properties by the big speeds of cooling. However, some tribotechnical properties, for example, it is possible even to rise by the increasing a quantity interstitial phase at hypereutectic alloy. Thus, high dispersion of crystals phases, which formed eutectic, will promote wear resistance increase. The micro-hardness obtained coating decries at the direction from a surface to substrate and changes in a range (2000–800) МПа. On fig. 4 the dependences of wear resistance for an electrospark coating to hypereutectic alloy XTH40 in comparison with wear resistance of an electrospark coating for eutectic alloy are presented, the tribotechnical properties of the cast state of the eutectic it is investigated in the robot [8].



a ***b***

Fig. 4. **It is intensity of wear electrospark coatings as dependants of specific loading:**
a **– hypereutectic alloy XTH40;** ***b*** **– eutectic alloy;** ***1*** **– experimental curve;** ***2*** **– approximation by a second degree polynomial**

The tests of friction were made by the scheme a ring on a ring under the conditions of a dry sliding friction [9]. The analysis was obtained dependences wear resistance from specific loading shows that the working capacity area of electrospark coating has essentially extended in comparison with eutectic composition. The hypereutectic coating can work at the bigger loadings, than eutectic coating. The magnitude of wear, obtained coating, also have essentially decreased at transition to hypereutectic area.

Conclusions

In case an electrospark coating deposition to hypereutectic alloy the 12H18N9-TiB_2-CrB_2 system the changing of mechanism eutectic crystallization takes place. The coating contains two types of structures: a thin conglomerate of phases and colonial; Due to high speed cooling a coating to hypereutectic alloy has very disperse structure. Both components of structure of the obtained coating contain disperse (Ø≤1μm) interstitial phase crystals; Due to disperse structure and the raiser containing the interstitial phases in a coating it is wear resistance obtained hypereutectic coatings essentially higher, than in a coating to eutectic alloy to the same system.

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Износостойкие покрытия на основе железа, полученные в неравновесных условиях электроискрового метода

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Установлены закономерности формирования в неравновесных условиях структуры и триботехнических свойств электроискровых покрытий из заэвтектического сплава на основе железа, содержащего фазы внедрения. Вследствие высокой скорости охлаждения покрытий заэвтектический сплав имеет очень дисперсную структуру. Оба компонента структуры полученных покрытий, содержат дисперсные кристаллы фаз внедрения. Благодаря дисперсной структуре и повышенному содержанию фаз внедрения заэвтектические покрытия имеют износостойкость существенно выше, чем покрытия эвтектического сплава той же самой системы.

Ключевые слова: заэвтектический сплав на основе железа, фазы внедрения, электроискровые покрытия, структура, свойства, высокая износостойкость.

Wear-resistant coatings on the iron basis, was obtained at nonequilibrium conditions of electrospark method

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Laws of formation and properties hypereutectic electro-spark coatings on the iron- basis alloy containing interstitial phases under nonequilibrium conditions are established. Due to high speed cooling of the coatings to hypereutectic alloy has very disperse structure. Both components of structure the obtained coating contain disperse interstitial phase crystals. Due to disperse structure and the raiser containing the interstitial phases in a coatings it is wear resistance obtained hypereutectic coatings essentially higher, than in a coatings to eutectic alloy to the same system.

Keywords: hypereutectic iron-based alloy, interstitial phases, electro-spark coatings, structure, properties, wears resistance.