B. Sereda
Dnieperovskyy State Technical University

OBTAINING WEAR-RESISTANT COATINGS UNDER SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS

For car parts working in conditions of wear process, sign-variable loadings, heats, speeds and pressure, and also aggressive corrosion environments, properties of a superficial layer have great value. In many cases the most widespread decision of the given problem appears set of a strong constructional material proof to temperature, deterioration, corrosion on working surfaces. The zinc coverings possess that specified properties. The received zinc layer consists of two zones: zones of zinc layers (chemical compounds of zinc and iron) and a transitive zone (a firm solution of zinc in iron). Zinc-plating to steel in conditions SHS promotes reception on its surface high quality diffusion coverings. Hardening of superficial layers carbonaceous steels method SHS allows to receive one thing -and the biphasic zinc coverings alloyed by chrome and aluminum, with corrosion stability 45-55 % above, than after zinc-plating a standard method.

Key words: *wear resistance, synthesis, micro hardness, zinc*

For machines details and units working in conditions of wear process, sign-variable loadings, heats, speeds and pressure, and also aggressive corrosion environments, properties of a superficial layer have great value. In many cases the most widespread decision of the given problem appears set of a strong constructional material proof to temperature, deterioration, corrosion on working surfaces. The zinc coverings possess that specified properties[1].

In this connection development of the new technologies providing reception of coverings of necessary operational characteristics at minimal time of their formation is actual. As such technologies ways of reception of coverings on the basis of a self propagating high-temperature synthesis [2] can serve.

A self-propagating high-temperature synthesis (SHS) represents high-intensity exothermal interaction of chemical elements in the condensed phase, capable to spontaneous distribution in the form of a wave of burning. Zinc-plating a working surface of materials by method SHS is carried out both in a mode of burning, and in a mode of thermal spontaneous ignition with a purge inert gas Unlike known ways zinc-plating formation of a covering by method SHS occurs in not isothermal conditions at which the essential role is played with chemical transport reactions. Such reactions proceed in powder mixes due to gas carriers at presence of a gradient of temperatures. Realization of chemical transport is provided by consecutive change of the separate temperature stages characterized by change of a level of temperature in each point of a mix from initial value up to temperature of burning.

The analysis of the reactions occurring at burning of the mixes, and also results of experiments and metallographic researches have allowed to receive the scheme of formation of a zinc layer in a mode of burning. This process can be divided into three stages.

The stage of passage of a wave of burning (stage I) is characterized by primary warming up of the sample and formation of a gas phase, enriched by zinc, thus the covering on a surface of the sample is not formed.

At a stage of warming up of the sample (a stage II) active atoms begin the diffusion its superficial layer due to the high potential predetermined by a gradient of concentration. At cooling a reactor (the stage III) goes down activity of formation of a covering because of reduction of factor of diffusion of a sating component at decrease in temperature. As have shown results the metallographic analysis, thickness of the given layer makes 7-10 microns.

Process of formation of zinc coverings in a mode of thermal spontaneous ignition can be divided into five stages.

At an initial stage (stage I) there is an inert warming up of a mix. At use as the supplier of the basic diffuse an element of technical zinc - formation of a zinc layer is observed; at use zinc oxide warming up of the sample and reactionary charge up to temperature of spontaneous ignition takes place only. Thermal spontaneous ignition of a reactionary mix (a stage II) is characterized by increase of its temperature with a speed 200-400 °C per second with up to maximal values. At this stage alongside with formation of active atoms of zinc there is an allocation of elementary chrome and its connection with the carrier (chlorine).

At a stage of warming up of the sample temperature drop of process up to the size corresponding settlement temperature zinc-plating takes place. Thus active atoms of chrome diffuse in a metal substrate the alloyed phase of zinc layers also starts to be formed.

During isothermal endurance (the stage IV) occurs formation constant diffusion a stream of active atoms of zinc. Thus growth of a zinc layer and alloy addition is observed by its chrome. At increase of duration of isothermal endurance the increase in thickness zinc diffusion a covering which submits to the parabolic law is observed. At this stage the temperature in a reactor does not change and the processes similar diffusion to saturation in stationary conditions proceed. It is necessary to note, that at process saturation occurs in the powder environment just the restored atoms of zinc and chrome. Besides austenite, formed at sharp growth of temperature, it is characterized by the raised density of dispositions, fineness and hollowness. In this connection at stage IV processes of diffusion saturation in such environments proceed more actively. At a stage of cooling (stage V) formation of a zinc layer occurs to smaller activity due
to reduction of factor of diffusion of zinc.

The received zinc layer consists of two zones: zones of zinc layers (chemical compounds of zinc and iron) and a transitive zone (a firm solution of zinc in iron). At increase in temperature and duration of saturation increase both the general thickness of a zinc layer, and thickness of a continuous layer of zinc and iron. The size of the last increases more intensively, that promotes increase of its compactness. The zinc covering received in conditions of thermal spontaneous ignition at temperature 500 - 750 °C, can represent both single-phase, and a diphase layer. The developed structures of mixes allow to receive the single-phase alloyed layers of type at the maintenance of zinc changing within the limits of 7 - 11 %. In all other cases the zinc layer has a biphase structure (fig. 2).

At zinc steel U8A the maintenance high zinc phases goes down, zinc adjoin porous allocation of a zinc phase. At formation of biphase zinc coverings the maintenance of the maximum zinc changes over a wide range. The conclusion about zinc coverings is made by chrome and aluminum on the basis of results of the chemical analysis of the received coverings which testify to presence of chrome and aluminum at a zinc zone. Besides some displacement diffraction maxima of zinc phases from the positions corresponding pure connections of zinc and iron is observed. Researches on the x-ray microanalyses testify that chrome during saturation diffuse in a superficial layer of a covering and settles down mainly on length of diffusion layer, its concentration reaches 1,4-2,7 %. Aluminums gets on all thickness of a zinc covering, its maintenance makes 0,8-1,3 %.

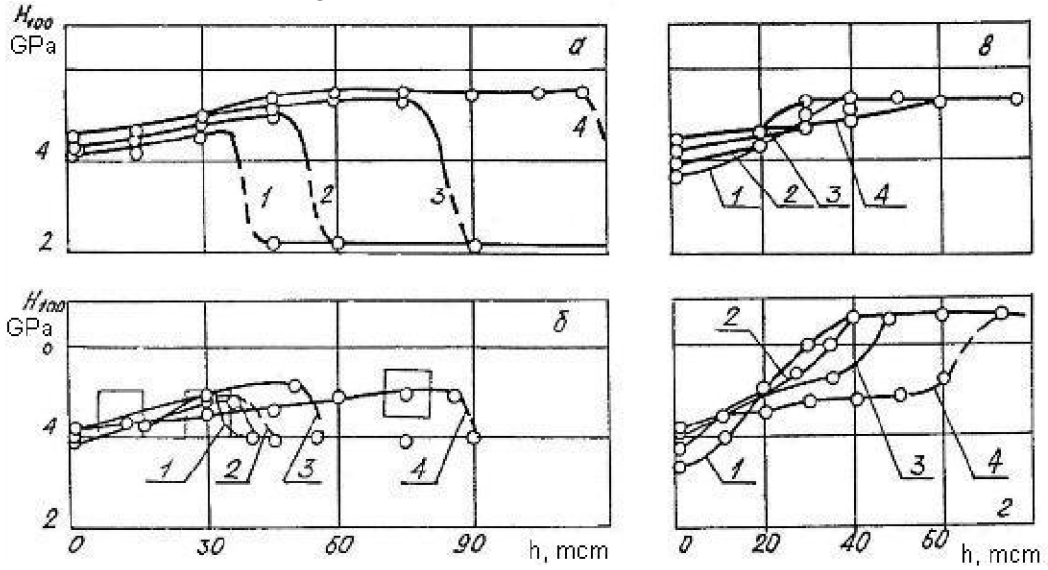

Fig. 1 Change of microhardness on depth of zinc layers.
Material of a substrate: and - technical iron, - steel 20, in - steel 45, г - steel U8A (t:1 - 550°C, 2 - 600°C, 3 - 700°C, 4 - 750°C).

At test of a biphase zinc layer it is established, that micro hardness of a zinc phase is between 3500-5500 Pa. In spite of the fact that diffusion zinc coverings give surfaces of products the raised wear resistance, their basic purpose - increase of corrosion stability. For increase of corrosion stability zinc coverings a number of technological receptions, including, and processing in solutions of various activators is offered. Application of the mixes impoverished on zinc allows to carry out process SHS-zinc-plating at temperatures 550-700°C.

Conclusions. Zinc-plating to steel in conditions SHS promotes reception on its surface high quality diffusion coverings. Hardening of superficial layers carbonaceous steels method SHS allows to receive one thing -and the biphase zinc coverings alloyed by chrome and aluminum, with corrosion stability 50-60 % above, than after zinc-plating a standard method.

Information sources

1. Merzhanov A.G. Combustion processes that synthesize materials. In. proz. Int. Conf. on Adv. In mater. And process. Technol. (AMPT), 24-27 August, Dublin, 1993, p, 513-532.

2. Khusid B.M. Mansurov V.A., Ubortsev A.D., Shulman Z.P.. Phase and chemical transformations in the self-propagating wave of an exotermal reaction in a mixture of organic powders. J. Chem., Soc., Faraday Trans., 1993, v. 89, № 4, p. 727-732.

3. Середа Д.Б. Получение хромоалитированных покрытий на углеродистых материалах в условиях самораспрастраняющегося высокотемпературного синтеза / Середа Б.П., Середа Д.Б.**.**, Белоконь Ю.А., Кругляк И.В. // Строительство, материаловедение, машиностроение: Сб. науч. трудов. Вып. 80 - Дн-вск.,ГВУЗ ПГАСА, 2015.-380с., С.296-301.

4. Середа Д.Б. Повышение износостойкости деталей газотурбинных двигателей в условиях самораспространяющегося высокотемпературного синтеза XIII международная научно техническая конференция „АВИА-2015”. –К.: НАУ, 2015.-С. 1172-1175

5. Sereda B., Sereda D. Advanced Chromoaluminizing Coatings for Wear and Heat-resistance on Composite Materials under SHS. Material science and technology- 2015.. Columbus, OH,USA.- 1821p., P.229-232.

6. Sereda B., Sereda D. Aluminized Multifunctional Coating on Steel in SHS Condition. Material science and technology -2014. Pittsburgh. Pennsylvania USA. 2224p. P.482-486.

7. Sereda B., Sereda D. Obtaining of Boride Coatings under SHS Conditions for Car Parts. Material science and technology- 2016. Salt Lake City, Utah USA 2016-1339p.-P.945-948.

Середа Б.П., *д.т.н.*

Дніпровський державний технічний університет,

ОТРИМАННЯ ЗНОСОСТІЙКИХ ПОКРИТТІВ В УМОВАХ ВИСОКОТЕМПЕРАТУРНОГО СИНТЕЗУ

В роботі представлені результати досліджень процесу отримання зносостійких покриттів з використанням явища саморозповсюджувального високотемпературного синтезу в режимі теплового самозаймання. Вивчено вплив складу СВС-шихти на теплові характеристики процесу і характеристики захисного покриття. Проведені дослідження показують, що СВС технологія отримання цинкових покриттів дозволяє отримувати якісну поверхню при обмеженому часі її формування.

Ключові слова: *зносостійкість, синтез, мікротвердість, цинк*

Середа Б.П., *д.т.н.*

Днепровский государственный технический университет

ПОЛУЧЕНИЕ ИЗНОСОСТОЙКИХ ПОКРЫТИЙ В УСЛОВИЯХ САМОРАСПРОСТРАНЯЮЩЕГОСЯ ВЫСОКОТЕМПЕРАТУРНОГО СИНТЕЗА

В работе представлены результаты исследований процесса получения износостойких покрытий с использованием явления самораспространяющеося высокотемпературного синтеза в режиме теплового самовоспламенения. Изучено влияние состава СВС-шихты на тепловые характеристики процесса и характеристики защитного покрытия. Проведенные исследования показывают, что СВС технология получения цинковых покрытий позволяет получать качественную поверхность при ограниченном времени их формирования.

Ключевые слова: *износостойкость, синтез, микро твердость, цинк*