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#### MODERN DEVELOPMENT THE TECHNOLOGY OF SHS

Yurii Zhiguts, Vasyly Lazar, Bohdan Hom'ak

#### СУЧАСНИЙ РОЗВИТОК ТЕХНОЛОГІЇ SHS

Жигуц Ю. Ю., Лазар В.Ф., Хом'як Б.Я.

*Tools are usually obtained by joining the cutting part to a steel holder (by brazing, welding, gluing and by other methods). New ways of fabricating tools have been devised in which self-propagating high-temperature synthesis (SHS) heat is used not only to the cutting alloy, but also to simultaneously weld it to steel holder of the tool. High heat ability is obtained by combining aluminothermy (the thermite process) with the SHS of carbide alloys, including "carbonsteel". The latter is a form of carbide alloys in which cobalt is replaced by tool steel.*

*Key words: self-propagating high-temperature synthesis, properties, thermite, carbide alloys, tool steel.*

*Інструменти, зазвичай, отримуються важче шляхом приєднання ріжучої частини*

до сталі (пайкою, зварюванням, склеюванням та іншими способами). Розроблено нові способи виготовлення інструментів, в яких саморозповсюдження високотемпературного синтезу (SHS) тепла використовується не тільки для різального сплаву, а й для одночасного приварювання його на сталевий держатель інструменту. Висока теплоємність одержується шляхом комбінування алюмотермії (термітного процесу) з SHS карбідних сплавів, у тому числі "карбонат". Останній - це форма карбідних сплавів, в яких кобальт заміщений інструментальною сталлю.

**Ключові слова:** саморозповсюдження високотемпературного синтезу, властивості, терміт, карбідні сплави, інструментальна сталь.

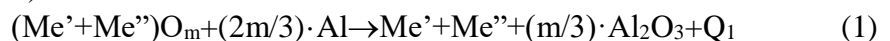
**I. Introduction.** SHS has been lately introduced into science and technology by A.G. Merzhanov and co-workers [1] as a means of obtaining refractory high-hard alloys and phases by using the chemical heat as a result of synthesis.

Very high burning temperatures (several thousand degrees Centigrade) can be attained by combining aluminothermic reactions (producing elemental metals – Fe, Cr, V, Mo, W, by reducing their oxides with the aid of Al powder) with the oxygen-less burning of these metals in carbon powder. Such combined reactions were called “hybrid” processes [2-5].

Medium high heat evolution processes have been used for hard-fazing of castings with carbides and /or borides surface layers by the in-mould route [3, 6-9]. In the present work high heat evolution processes have been employed in the production of medium size cutting tools in order to compensates high heat losses because of rather small volumes of reacting powder mixtures and also in order to simultaneously weld the carbides metal obtained on the steel holder of tools.

**II. Theory and experiment.** The “hybrid” high temperature processes devised can be described by the following reactions:

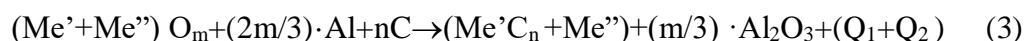
Stage 1 (thermite process):



Stage 2 (oxygen-less burning):

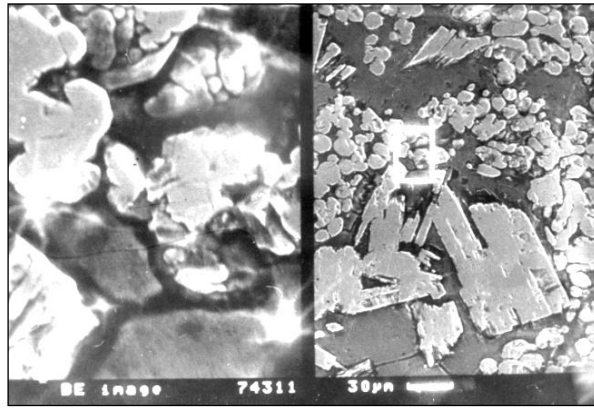


Total:



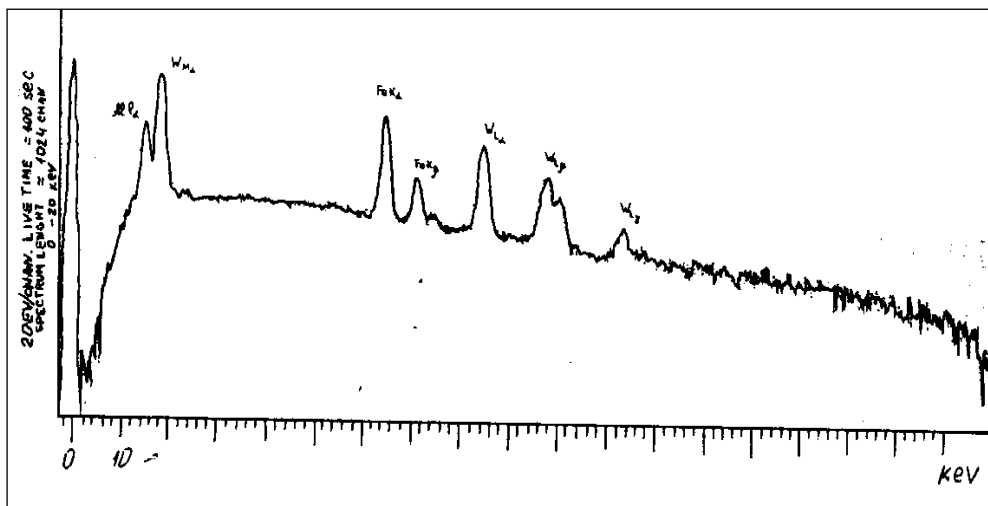
Here  $Me'$  is the carbide-forming element (e.g. W) and  $Me''$  is the metal that is not combined with carbon but forms the plastic matrix which binds together the hard carbides  $Me'C_n$ . In usual carbide alloys  $Me''$  is cobalt. In “carbonsteel” [2] Co is replaced by alloyed tool steel, e.g. 12% Cr or high-speed steel (HSS). In Eq. 1 and 3 the ratio  $Me'/Me''$  is not specified. This ratio is very important because it influences the total heat evolution  $Q=Q_1+Q_2$  and also the ratio carbide phase/cobalt or tool steel matrix in the carbide alloy or in “carbonsteel”. In case of the synthesis of “carbonsteel” surplus carbon must be added to the powder mixtures as per Eq. 2 because this extra amount is necessary to carburise the austenite+martensite metal matrix. When this matrix is alloyed with Cr or with W+Cr the dissolution of carbon in the liquid iron-based highly hard alloyed solution gives a small additional evolution of heat  $Q_3$  which supplements the sum  $Q_1+Q_2$ . A programme for computer aided calculations of  $Q_1$ ,  $Q_2$  and  $Q$  has been elaborated and has been used in ref.3. In fig. 1 we have shown the microstructure of “carbistal” and of its steel matrix.

This “carbonsteel” has been obtained by the “hybrid” process using  $Fe_2O_3$ ,  $Cr_2O_3$ ,  $WO_3$  graphite and aluminium powder mixtures. Tungsten binds most of the carbon into large WC carbides, shown in fig. 1. Another part of tungsten binds carbon into small WC carbides forming the complex eutectic matrix. This matrix may also contain small amounts of other carbides:  $Me_7C_3$ ,  $Me_6W_6C_2$  et al. In fig. 1 we can see that these eutectic carbides have been strongly spheroidised during recasting, when sharp edges have been rounded up.



**Fig. 1. Microstructure of a “carbonsteel” produced by the SHS (self-propagating high-temperature synthesis): a - massive WC carbides in an ultra high-carbon high-tungsten steel matrix (magnification x 100); b-matrix with spheroidized complex carbides (magnification x 400)**

Fig. 2 shows the x-ray spectrum of this alloy obtained in  $CuK\alpha$  radiation. Only the WC and  $W_2C$  carbide phases are seen in it. The iron-rich phase is  $\alpha'$ -martensite obtained after self-quenching and triple tempering at  $570^\circ C$ . The hardness of the alloys obtained in such a new way is 72-75 HRA [2].



20 ev/chan, spectrum length = 1024 chan 0-24 keV

**Fig. 2. X-ray spectrum of "carbidoestal" obtained in  $Cu K\alpha$  radiation**

Medium size cutting tools have been obtained by burning thermite+SHS powder mixtures in a highly refractory combustion chamber placed over a small refractory mould surmounting the preliminarily heated steel holder of the tool.

The combustion chamber and the mould must be separated by a thin titanium sheet.

The exothermic mixture is ignited by a small amount of  $Mg$  or  $Ti$  powder, which is ignited itself by an ordinary match. When burning reactions end the slag floats up and the extremely hot liquid phase burns through the titanium sheet and fills the ceramic mould, being thus automatically welded to the steel holder of the tool. Such technology excludes brazing and other operations, designed to join the carbide alloy to steel.

A number of different types of tools for metal cutting and rock boring have been produced in such a novel way with good exploitation features in semi-industrial and laboratory conditions. The further work must be focused on augmenting the content of primary WC carbides in the “carbonsteel” obtained, the partial replacement of  $WO_3$  by  $TiO_2$  and other subjects of investigations.  $TiO_2$  is much less prone to oxidise  $Al$  than  $WO_3$ , the thermite-type reaction being much less

exothermic in case of replacement of  $W$  by  $Ti$ . Therefore, such full replacement is impossible. Yet the SHS reaction  $Ti+C=TiC$  is very "hot", the adiabatic temperature of such an oxygen-less burning being 3200 K. More exact computations and experiments must reveal the extent of partial replacements of that type.

**III. One of the directions of application of SHS.** The laser surface hardening (LSH) of metals was discovered in 1965. Nowadays in the whole world hundreds of patents have been awarded to branch inventions including those dealing with combination of LSH with SHS (self-propagating high-temperature synthesis). In the given investigation the mixture of powders  $Ti$  (68%), carbon in black state (18%) and  $Fe$  (14% by mass). The mixture was damped by solution of 2 % latex in gasoline, then it was put on the surface of stalls of mark 10 and 20 and was dried in an open air, forming the layer 80, 200 or 500 mkm thick. Those layers were burnt by  $CO_2$  laser of continuous action with longitudinal pumping of "Cardamon" type 850 W of power under tightness of power  $15-20W \cdot m^{-2}$ , the speed of scanning was being changed in the limit of  $10-20 mm \cdot c^{-1}$ . After the experiment was made macro- and microhardness in alloy layer, in the zone of thermal influence and in the base metal were being measured.

Typical microstructure of metal consists of ~50% particles  $TiC$  and ~50% (by volume) metallic link – instrumental carbon steel of type 48. The investigations made proved that the microhardness of carbides  $TiC$  is almost 10 times higher than the hardness of steel and reaches  $HV$  1400 (14000 MPa). The substitution of a part of iron in the SHS-mixture by ferrochrome increases greatly corrosion resistance of "carbonsteel" and decreases its oxidizing wear in the process of its exploitation. The substitution of carbon in SHS-mixtures by the powder is also long-range.

**IV. Conclusion.** Combination of LSH and SHS in one operation allows to solve the whole complex of technical problems connected with producing of materials with high hardness like "carbonsteels" and hard alloys on metal surface: 1) evolution of inner chemical heat in SHS-mixtures allows to decrease the power of laser radiation; 2) new complex technological process allows to build up wearied surfaces of parts of machines and devices to the high of 0,5 mm; 3) laser ray as a source of heat may be substituted by electronic ray or by another carrier of energy.

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### ADVERTISING ACTIVITIES IN RURAL GREEN TOURISM

Zelenska Liliia, Luzhanskaya Tetiana, Movchan Kateryna

### РЕКЛАМНА ДІЯЛЬНІСТЬ В СІЛЬСЬКОМУ ЗЕЛЕНОМУ ТУРИЗМІ

Зеленська Л. В., Лужанська Т.Ю., Мовчан К.М.

*The article deals with the types of advertising activities of rural green tourism. Analysis of expenses for advertising services has been carried out. The way of increasing the efficiency of implementation of advertising activities for enterprises of rural green tourism have been determined. The principles of advertising of rural green farms have been investigated.*

**Key words:** rural green tourism, advertising activity, rural homestead.

*У статті розглянуто види рекламної діяльності сільського зеленого туризму. Проведено аналіз витрат на рекламні послуги. Визначено шляхи підвищення ефективності впровадження рекламної діяльності для підприємств сільського зеленого туризму. Досліджено принципи рекламування сільських зелених садиб.*

**Ключові слова:** сільський зелений туризм, рекламна діяльність, сільська садиба.

Successful organization of rest in rural green farms requires a certain amount of realized products and services. Only certain types of products and services offered on the market of tourist services are acceptable to all consumers. But a large percentage of people do not have information about some kinds of rest, and therefore they do not know about their existence and they will not use them. Providing awareness of potential customers about your activities and services requires a number of promotional activities.

Analysis of basic research and publications. Such scientists have devoted their works to the researches on the effectiveness of advertising and solving the problem of choosing an effective type of advertising for rural tourism: V. K. Babritskaya, A.T. Kirilov, O. Yu Malinovska, I. T. Balabanov, O. I. Balabanov, T. I. Lukianets, A. V. Kostina, I. V. Novikova, G. G. Pocheptsov, L. A. Volkova. In the works of the above mentioned authors, the issue of ensuring the advertising activity in the context of the functioning and development of rural estates has been considered.

The purpose of the study is to analyze the effectiveness of the main types of advertising and the direction of effective dissemination of information about rural green tourism.

Presenting main material. Today, the implementation of high-quality advertising activities, as a rule, costs a lot of money and effort, which is quite burdensome for the owners of rural farms, providing services in rural (green) tourism. The advertising of their services, of course, depends, on the one hand, on the owner of the homestead, and, on the other hand, on the specifics of the audience to which this advertisement is directed. The success of the operation and bringing profit from the homestead depends on how many guests can attract to their own green homestead. That depends on your profit.



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