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International Association «Welding»

Translators

A.A. Fomin, O.S. Kurochko, I.N. Kutianova

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Electron galley

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Tel.: (38044) 200 60 16, 200 82 77

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E-mail: journal@paton.kiev.ua

www.patonpublishinghouse.com

State Registration Certificate

KV 4790 of 09.01.2001

ISSN 0957-798X

Subscriptions

\$348, 12 issues per year,

air postage and packaging included.

Back issues available.

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Activities of the E.O. Paton Chinese-Ukrainian Welding Institute



The E.O. Paton Chinese-Ukrainian Welding Institute (CUWI) is a form of international scientific and technical cooperation in the PRC, which represents a platform for promotion and implementation of achievements and experience of the E.O. Paton Electric Welding Institute (PWI) of the National Academy of Sciences of Ukraine (NASU) and other institutions of the NASU as well as Ukrainian research institutions and enterprises in China and Ukraine, and also to conduct joint developments and joint high-tech production in the field of shipbuilding, marine engineering, aviation, railway transport, extraction and transportation of oil and gas, power engineering, energy saving and other fields of industry with Chinese partners.

Such a form of cooperation has no analogs in the scale of implemented projects.

The establishment of CUWI was approved and affirmed by the following international agreements and documents signed at the level of PWI with the Governmental organizations of China and the documents signed at the level of Ukrainian and Chinese authorities:

- ♦ Agreement on establishment of CUWI, signed by PWI, Guangdong General Research Institute of Industrial Technology (GGRIT) and Guangdong Science and Technology Department on 24 February, 2011;

- ♦ Regulations about CUWI, signed by PWI, GGRIT and Guangdong Science and Technology Department, Guangzhou Science and Information Department on February 24, 2011;

- ♦ Memorandum of Understanding between the Ministry of Science and Technology of PRC and the State Agency for Science, Innovation and Information of Ukraine and rendering support for establishment of CUWI, signed in May 2011;

- ♦ Intergovernmental agreement between PRC and Ukraine on economic and scientific-technical cooperation signed in the framework of the State visit of the Head of PRC to Ukraine in 8–20 of June, 2011.

At present, according to the Chinese legislation, CUWI, which is a part of the Guangdong Academy of Sciences. All the activities on international cooperation in the frames of CUWI are funded by the Chinese party. The sources for receiving funds of the Chinese party are the applied projects of the PRC Central Government, Government of Guangdong Province, Guangzhou, or state industrial corporations as well as joint-stock and private companies in the PRC. The financial support of projects is carried out on a competitive basis, i.e. to receive funds in China for each project in the



Signing of official documents on establishment and activity arrangement of CUWI (2012–2013): *from left to right*: Mr. Zhu Xiaodan, Governor of Guangdong Province; Prof. B.E. Paton, President of the NASU, Honorary Chairman of the CUWI Council; Mr. Cao Jianlin, Deputy Minister of Science and Technology of PRC, Honorary Chairman of the CUWI Council; I.V. Krivtsun, Academician of the NASU, Deputy Director of PWI, Chairman of the CUWI Council



Equipment for flash-butt welding, developed at PWI and delivered to the laboratory and technological base of CUWI in Guangzhou

competition the state institutions and enterprises of PRC, as well as leading foreign companies in the field of welding and related processes are involved.

Within the scope of CUWI in realization of international projects a number of institutes of the NASU, leading technical universities of Ukraine as well as large industrial enterprises and research-and-production innovation companies participate. In particular, except of PWI in such cooperation within the framework of CUWI, I.M. Frantsevich Institute of Problems of Materials Science and Physical-and-Technological Institute of Metals and Alloys participate. Among technical universities in international projects in the framework of CUWI, NTUU «Kiev Polytechnic Institute» and Admiral Makarov National Shipbuilding University most actively participate. Also, for the fulfillment of production tasks, in particular, for production of critical units of high-tech equipment, CUWI attracts a number of industrial, scientific-and-industrial enterprises from different regions of Ukraine, in particular, from Dnepropetrovsk, Kharkov, Zhitomir, Nikolaev, Kiev, Sumy and other cities of Ukraine.

Main directions of works and joint projects in the PRC on which CUWI is currently working:

- ♦ development of universal equipment and technology of flash-butt welding of structural steels, aluminum and titanium alloys and their industrial application;



Prototype of machine for producing welded joints of titanium and titanium alloys of up to 4 m length and up to 120 mm thickness (a), and macrosection of welded joint of titanium of increased thickness (b)



Innovative universal equipment for plasma, hybrid and combined (tandem) plasma-MIG welding, developed at PWI and delivered to the laboratory and technological base of CUWI in Guangzhou

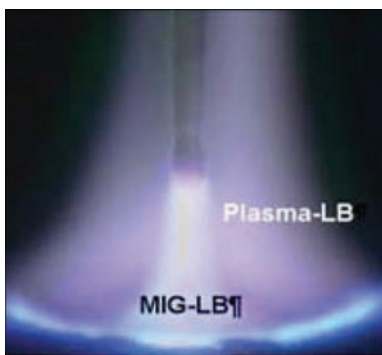
- ♦ creation of new generation of equipment for flash-butt welding of pipes (114–320 mm), preparation of organization of its joint production in the PRC;

- ♦ creation of advanced flux-cored wires for arc welding of high-strength steels, surfacing and spraying, development of technology for their production, including improvement of reliability and longevity of critical structures of high-strength steels of the offshore platforms for oil and gas production;

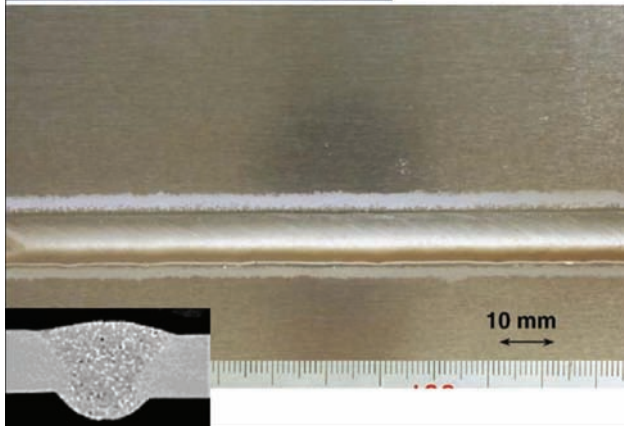
- ♦ creation of technology and universal equipment for high-speed plasma, hybrid and combined (tandem) plasma-MIG welding, its integration into robotic complex;

- ♦ development of technology and equipment for orbital welding over the flux layer (A-TIG) of pipelines for power equipment;

- ♦ creation of technology and new generation of equipment for microplasma (plasma) and hybrid laser-microplasma (plasma) welding using pulsed current at variable-polarity modes;



Hybrid «Plasma-MIG» welding process

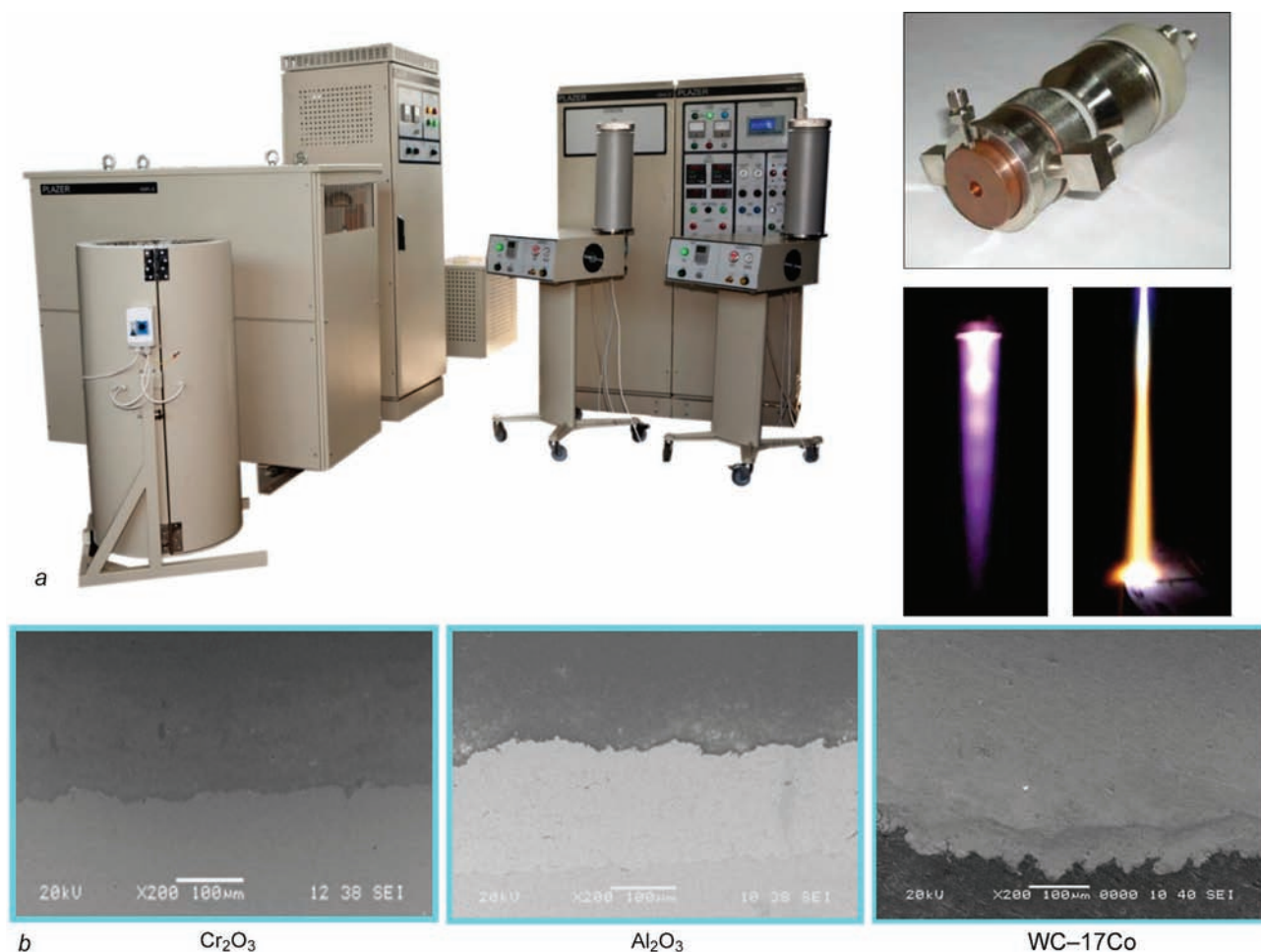


Appearance of weld of Al–3 % Mg alloy produced using hybrid «Plasma-MIG» process ($\delta = 5$ mm, $v_w = 50$ cm/min)



Line for production of flux-cored wires for arc welding, surfacing and thermal spraying at the laboratory and technological base of CUWI in Guangzhou





Appearance of equipment, supersonic plasma spraying process, developed at PWI and delivered to the laboratory and technological base of CUWI in Guangzhou (a), and produced high-quality ceramic and metal-ceramic coatings (b)

- ◆ development of technology of diffusion welding of Ni_3Al -based heat-resistant alloys with controlled stress-strain state;
- ◆ modification of equipment for high-frequency welding of live tissues, its adaptation to the working conditions at the Chinese medical institutions;



Laser welding and cutting as well as hybrid laser welding with two robots using 10 kW laser at the laboratory and technological base of CUWI in Guangzhou (deep penetration laser welding, hybrid laser-MIG welding, laser welding using scanning, laser welding using two beams, 3D laser cutting)

焊接研究与应用

WELD RESEARCH AND APPLICATION



2014年6月第1期 设备·材料·工艺·应用

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- ♦ development of new compositions of powders of high-strength titanium alloys and technologies of their production applying plasma technologies;

- ♦ development of new technologies for plasma titanium-steel welding and their introduction into production of bimetallic pipes for oil and gas transportation;

- ♦ creation of specialized equipment and technology of orbital plasma welding of titanium pipes for the needs of oil and gas production;

- ♦ creation of specialized equipment and technology of high-efficient (up to 45 kg/h) electroslag two-strip surfacing of large products of power engineering equipment;

- ♦ creation of equipment and technology of electrodynamic treatment of welded joints of aluminum alloys for shipbuilding with the purpose of efficient reduction and control of welding deformations;

- ♦ development of technology and equipment for high-efficient plasma cutting of metals of high thicknesses (up to 120–200 mm) at reverse polarity, its integration with the systems of numerical program control as-applied to the produc-

tion of large-size structures;

- ♦ development of technology and equipment for automatic narrow-gap arc welding in controlled magnetic field of long structures (up to 4 m) of titanium alloys of increased thickness (up to 120 mm);

- ♦ development and application of advanced technologies for manufacture and repair of gas turbine blades based on advanced welding and electron beam technologies;

- ♦ development of innovative technologies for welding, cutting and life improvement for manufacture of hull structures of vessels (including polar transport icebreakers) using advanced welding-and-assembly processes.

Creation of laboratory and technological base of CUWI in the PRC. To carry out joint works on realization of projects of international scientific and technical cooperation at the facilities of CUWI in the PRC, the laboratory and industrial areas were created, where at the moment more than 25 different types of experimental-industrial equipment were installed, including those developed at PWI and supplied by the Ukrainian part, namely, line for production of new types of flux-cored wires for welding, surfacing and spraying; equipment for flash-butt welding (two installations for welding of



Awarding the CUWI Director on the PWI part V.N. Korzhik (from the left) (from the right: Vice Premier of the PRC State Council Ma Kai)

pipes and parts of other profiles); equipment for welding of live tissues (4 devices); universal equipment for hybrid and combined (tandem) plasma-MIG welding; installation for A-TIG welding; installation for supersonic plasma spraying of coatings; high-power laser (10 kW) and equipment for laser and hybrid laser-MIG welding; different equipment for arc welding (TIG, MIG, friction, FSW, etc.), as well as the equipment for arc surfacing and high-efficient electroslag two-strip surfacing.

Scientific achievements of CUWI. In the process of international scientific and technical cooperation in the CUWI framework, the following basic scientific achievements in the field of fundamental investigations of physical processes of transfer of energy, mass and charge in arc, plasma, laser, hybrid plasma-arc and laser-arc welding, plasma spraying, for the development of new innovative technologies and related equipment on this basis, were gained:

- ♦ software for theoretical investigations and computer modeling of processes of transfer of energy, pulse, mass and charge in column and anode region of welding arcs, as well as for numerical modeling of thermal field and field of dynamical changing in the weld pool in hybrid laser-arc welding was developed;

- ♦ mathematical models and software for calculation of temperature field, field of velocities and electromagnetic characteristics of arc plasma generated by plasmatrons of direct action, characteristics of thermal and dynamic interaction of plasma with the material being welded, were developed;

- ♦ computer program for modeling (calculation of dimensions and shape) of single-pass butt welds in A-TIG welding was developed;

- ♦ computer program for mathematical modeling of stress-strain state and mechanical properties of material in the zone of circumferential butt welded joint in arc welding (A-TIG and TIG) was developed;

- ♦ technological principles of hybrid plasma welding with axial current-carrying wire («Plasma-MIG») were developed, technical solutions for creation of hybrid plasmatrons and installations for plasma hybrid welding were created.

Using opportunities of CUWI in China, PWI participates actively in international conferences and exhibitions on welding and related technologies with reports on developments and experience of PWI in implementation of welding technologies. Keeping the course of CUWI, the PWI staff members delivered nearly 25 reports at the international scientific and technical conferences, published more than 35 scientific papers in different leading top-rated scientific and technical journals of the PRC, as well as in the USA, Ukraine, EU and other countries, prepared nearly 30 scientific papers for publication. The applications for 10 patents were submitted in the PRC, 19 patents were prepared for submission in the PRC and Ukraine.

Estimates of the CUWI activity results. CUWI has a high prestige in the PRC, the activity results of CUWI and contribution of PWI to this activity were highly appreciated by the PRC Government. In particular, Prof. Korzhik V.N., Director of CUWI on the PWI part, was awarded a number of governmental awards and titles of PRC (Medal of Guangdong Government «For high achievements in international scientific-technical and economic cooperation», 2013, and highest award of the PRC Government and the State Administration of Foreign Experts, 2014) and also was awarded with honorary titles (international expert of the Chinese Ministry of Human Resources and Social Security, honorary citizen of Guangzhou).

Prof. Korzhik V.N.,
CUWI Director on the PWI part

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