EUREKA PROJECT E!2123- GEFEST

1. General description

Project	E! 2123- GEFEST	**Status**	Finished- 08-Jul-2004
Title	**New Generation Of Effective Hot Forging Equipment**		
Class	Project	**Technological area**	New Materials
Start date	01-Jun-1999	**End date**	01-Jun-2002
Duration	36months	**Total cost**	1.05Meuro
Partner sought	No		
Summary	The Aim Of The Project Is To Develop Effective Methods To Improve Forging Tool Life And Regenerate Such Tools. To Achieve This, Laser Treatment And Surfacing Methods Are Proposed.		

Budget and duration

Phase	Budget(Meuro)	Duration (Months)
Feasibility phase	0.08	4
Definition phase	0.12	6
Implementation phase	0.63	18
Full Exploitation	0.22	8
Total	**1.05**	**36**

Member contribution

Member	Contribution	Position	Since
Poland	**62.00%**	**Notified Finished**	**08-Jul-2004**
Ukraine	18.00%	Notified Finished	08-Jul-2004
Russian Federation	20.00%	Notified Finished	08-Jul-2004

Participants

Company	Country	Type	Role
Inop - Metal Working Institute - Surface Working Laboratory	**Poland**	**Research Institute**	**Main**
Technical University Of Czestochowa Metal And Plastics Forming Institute	Poland	University	Partner
Russian Academy Of Sciences Scientific Research Center For Technological Lasers	Russian Federation	Research Institute	Partner
Academy Of Sciences/E. O. Paton Electric Welding Institute	Ukraine	Large company	Partner
Zaklady Kuznicze Sp. Z. O. O.- Department Of Design	Poland	Large company	Partner

2. Project outline

Project description

The short service life of forging tools is a significant economic problem of forging production both in POLAND and in those countries with a high level of industrial development. The contribution of tool costs to the total production cost in Polish forges is 10-15%. Forgery tools work in very hard conditions due to high mechanical loads, abrasive wear and the high temperature tempering action. The operating characteristics of such tools depend mainly on the properties of their surface layers. Among modern methods of improving tool service life by forming wear-resistant surface layers are, among others, the technologies of laser surface treatment (LST) and surfacing. Many of those techniques offer the possibility of improving local properties e.g. of impression edges, which is very important in forging tools.
The present project proposes the investigation and subsequent application of:
* laser surface treatment of severely worn impression layers. The advantage of this method is quick local heating and cooling, which results in a layer of unique properties, that cannot be obtained by other methods (e.g. high hardness and wear-resistance with minimum product deformation). The essential feature of LST technology is computer controllability of the processes and the utilisation of on-line remote diagnostics. All LST processes are environmentally-friendly.
* surfacing, which can be applied for life improving and regeneration of dies including those of large overall dimensions. In this way, severely worn tool fragments, particularly edges and corners, can be improved or regenerated.
The project development includes:
1. Determination of the working conditions of forging tools for hot work depending on, the forging size and shape, material grade, technical conditions of forging based on laboratory investigation and numerical simulation.
2. Determination of properties of tool surface layers as far as the aspect of their chemical composition, layer applying technologies and treatment are concerned.
3. Organization of investigation stands.
4. Industrial tests.
5. Technical and economical analysis of various tool surface hardening techniques.
6. Drawing up of guidelines for industrial practice.
7. Implementation of the investigation results in domestic forges.
The ultimate purpose of the project is, therefore, the drawing up of effective methods of improving the service life and regeneration of forging tools.

Technological development envisaged

Forging tools for hot working, which are the object of the present investigation project, are produced by machining, heat treatment and, in some cases, thermochemical treatment. Forging tool life depends on the following factors:

- the grade of the material deformed;
- forging shape and mass;
- temperature of forging operation;
- the lubrication technique;
- the kind of forging device applied.

In industrial practice, a large variety of forgings are made and, consequently, various tool working conditions occur, which influences their rate of wear. So far no explicit theoretical and empirical relationships have been found between thermo-mechanical load and tool wear.

As far as the character of destruction processes is concerned, forging tools can be grouped as follows:

- those in which abrasive wear dominates;
- those in which thero-mechanical fatigue dominates;
- those in which plastic strain of the impression dominates.

Depending on the dominant wear process, the surface treatment method and the chemical composition of the surface layer are to be selected.

Contemporary effective methods of improving the working surface of forging tools are laser treatment and pad welding, hence the application of the two methods for surface treatment and regeneration of forging tools is proposed.

Laser surface treatment consists in local hardening, alloying cladding or sintering tool fragments using a high power laser beam. A significant advantage of the method is the local character of the laser beam-material surface interaction, computer controllability of the process, on-line remote diagnostics. Laser treatment makes it possible to form layers with suitably selected chemical composition, as well as to perform heat treatment of working surfaces, the whole tool or its fragments.

Surfacing can produce layers of exceptionally high wear resistance and thermal fatigue resistance. It is particularly advisable to use the technology for hardening the working edges of die impressions, blanking dies and regenerating them. When pad welding is applied for surface treatment and regeneration of forging tools, special attention has to be paid to the selection of the electrode chemical composition and surfacing parameters, depending on the overall dimensions and destination of the tools.

Surfacing with flux-cored wires of special chemical composition and gas shielded pad welding are intended.

Technical literature does not precisely specify the surfacing conditions for forging tools or recommended surface layer properties after the process (chemical composition, hardness, impact strength). The application of numerically controlled surfacing devices and lasers will allow the required precision to be maintained with respect to the layer quality obtained.

The advantages of the two surface treatment technologies are, among others:

- small overall dimensions;
- local range of the layers applied;
- low material and energy consumption;
- environmentally safe.

The above technologies can also be applied for treating and regeneration of responsible machine parts or other tools, e.g. pressure casting dies.

The present work deals with:

- classification of forgings with regard to requirements, design and execution technology;

- development up of surface layer improving and regeneration technology by the LST or surfacing method;
- design and execution of automated working stations (units) for LST or surfacing;
- implementation of the results in domestic forges.

Note under Relationship to other EU Programmes:
E! 56 PROTOS II - the project was aimed at developing process and materials for improved surface properties of turbines. The results obtained are relevant to turbines and cannot be applied to forging tools.
EU 67.1 - The project was aimed at evaluating the influence of surface remelting on microstructural changes and wear resistance of cold work tool steels. The subject of the project has no direct relationship to our project.
EU 73 - the project concerned the combination of an off-line programming system, a robot and an ND YAG laser. The subject of the project is only indirectly related to our project.

Markets application and exploitation

Two pilot stations are to be built under the project to perform the LST technologies and padding. The innovation of the project consists in forming composite layers, wear-resistance and thermo-mechanical fatigue, on highly loaded surface of tools working at high temperatures, e.g. forming dies. This is to be effected by combination of several surface engineering technologies, e.g. laser alloying, padding and ion nitriding, gas-powder padding. The chemical composition of the layers will be selected to form an anti-adhesion layer, preventing forged material sticking, which is important when forging highly deformable materials such as stainless steels and titanium alloys.
The developed hardening treatment methods can also be used for other tool groups, e.g. casting moulds, moulds for plastics, as well as for regenerating worn tools.
Since the universal stands will have good possibilities to adapt the technology for a vast range of tools, they can be widely implemented, both domestically and abroad.
In POLAND, the following firms have been found to be interested in modern technologies improving tool life and in material saving regeneration methods: forgery enterprises, SKOCZOW; marine equipment, factory BOMET, Barlinek; DIE FORGERY, Stawola Wola; H. CEGIELSKI, Poznan; Factory of Rolling Bearings, Krasnik; ANDRZEJ IRON MILL, Zawadzkie.
METAL FORMING INSTITUTE.

Project codes

BSI

AUC	surfaces
AUR	treatment
N	mechanical engineering
PQ	machine tools
TB/TG	materials by form
UVO	metalworking

NACE

2752	Casting of steel
281	Manufacture of structural metal products
2840	Forging, pressing, stamping and roll forming of metal; powder metallurgy
285	Treatment and coating of metals; general mechanical engineering
2862	Manufacture of tools

3. Main participant

Company

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Organisation type Research Institute
Participant role Main

Contribution to project

Selection of surface layer properties and manufacturing technologies, test stand organisation and realisation of technological investigations performance, results analysis, drawing up of industrial practice instructions.

Expertise

Is a leading scientific and research enterprise in POLAND, designing technologies, machines and devices for plastic working of metals. The scope of scientific and research works includes, among others, stamping, orbital forging, and forging in special devices. Hundreds of S-R works have been implemented in Polish and foreign industry. Licences have been sold to many countries. The highly qualified staff consists of Professors, Assistant Professors, Doctors, and Engineers, with many years of industrial experience. INOP has a well equipped metal investigation workshop.

4. Partner

Company

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Organisation type University
Participant role Partner

Contribution to project

In the laboratory investigations will be carried out aiming to determine: wear resistance at high temperature, thermo- mechanical fatigue resistance of the formed hardening layers, and the assessment of their suitability.

Expertise

The Institute is a scientific and research unit of P. CZ. In addition to its educational activities, scientific research work is carried out, mainly in: optimisation of the forging, stamping, extrusion processed based on computer simulation, abrasive wear investigations of tool materials and investigations on technological lubricants. The scientific specialty of the Institute is tribological investigation. The Institute possesses a lot of equipment and investigation devices, both standard and some of their own design.

4. Partner

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Organisation type Research Institute
Participant role Partner

Contribution to project

Investigation into the influence of laser surface treatment process parameters on the quality of the surface layer obtained in the treated tools. Application of the results of the developed technologies in industrial enterprises.

Expertise

The Laser Research Center (NICTL) carries out R & D work in the field of high power CO2 lasers and laser materials processing (technologies and equipment). It has a staff of 500 people (130 scientists, among them

15 Doctors of Science and 70 Ph.Ds, and 150 Engineers), consists of 15 laboratories and disposes of 25 experimental sets for laser and processing R & D, and pilot laser equipment plant.

4. Partner

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Organisation type Large company
Participant role Partner

Contribution to project

Drawing up of modern efficient methods of pad welding with cored electrode for forging tools. Selection of materials and technological parameters.

Expertise

Is now a multiprofile scientific and research complex carrying out fundamental and applied scientific investigations, developing technology, materials, equipment and control systems, efficiently welded structures and components, methods and means of diagnostics and non-destructive quality inspection in the following areas: - advanced methods of welding and joining materials; - surfacing, coating and surface treatment technologies; - strength, reliability and endurance of welded structures; - special electrometallurgy processes; - new structural and functional materials.

4. Partner

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Organisation type Large company
Participant role Partner

Contribution to project

Determination of tools working conditions in the forgery, tools classification in respect of wear character, tools life investigations, practical application of investigations in industry.

Expertise

Produce high quality forgings, hot die forged of steel, mainly for the car industry. Our machinery allows to produce forgings whose weight will be between 0.05 KG and 25 KG. In 1995 the ZAKLADY KUZNICZE LTD. received a certificate for TUV CERT BERLIN BRANDEBURG, proving that a quality control system is in place to meet the requirements of the DIN EN ISO 9002 Norm. We apply a statistical control of the process -SPC- as well as analysis of potential deviations based on the FMEA Method. In 1996 the plant was awarded a cleaner production certificate.