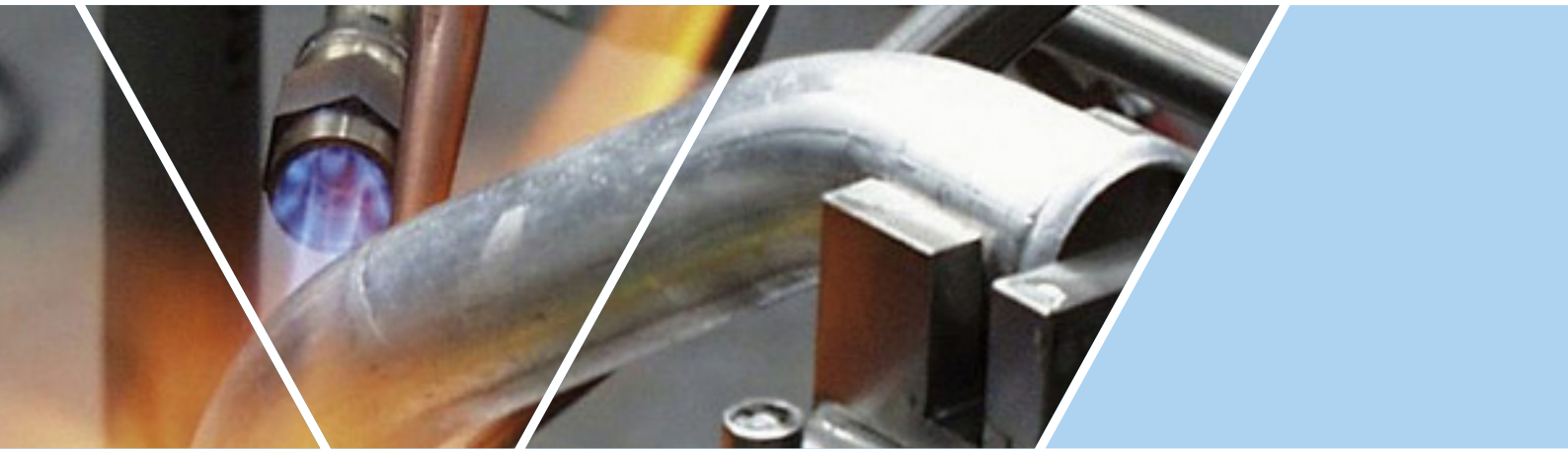
DVS THE JOINING SPECIALISTS



RESEARCH | TECHNOLOGY | EDUCATION

IN FOCUS

Brazing in DVS

www.the-joining-specialists.de

The technical-scientific cooperative work in the DVS

DVS is a technical-scientific association that is fully committed to joining technology, with nearly 120 years of experience under its belt. In other words: at the DVS, everything revolves around joining, cutting and coating of metallic and non-metallic materials and material composites. The objective of all DVS activities is to comprehensively promote joining technology. This is done in many different ways.

DVS initiates and accompanies research activities, grasps the current state of the art, develops it continuously and makes sure that the DVS training and continuing education offerings, too, reflect the respectively latest state of knowledge from technology and research. This narrow network made up of research, technology and education is the core element of the technical-scientific cooperative work in the DVS.

True to the principle „one becomes three“ technical discussions, research questions, or work results are communicated across the various departments, which is why they also mutually positively influence one another. With this interdisciplinary approach, the DVS guarantees that its varied work results will always be based on the latest findings and are mutually compatible with each other.

An impressive example of this successful working philosophy is being documented by the DVS set of rules, consisting of DVS fact sheets and DVS guidelines. For the training and continuing education, the DVS set of rules sets high training standards and comparable qualifications. In the technical areas, joining, cutting and coating methods, however, also aspects of testing and quality assurance, industrial safety and environmental protection as well as the added upstream and downstream process stages are being currently described. The foundations for the highest standards and uniform procedures are specified by the DVS set of rules.

With the series of booklets titled “in Focus”, we would like to demonstrate to you with the help of specific examples which practically oriented results the technical-scientific teamwork produces in the DVS and would like to invite you to get involved in the varied activities in the DVS. Every booklet is dedicated to a central topic of interest and shows how the close connection between research, technology and education in the DVS not only benefits the respective industry but the entire industrial location of Germany. The DVS offers competitive solutions for joining technology – the work results are published among other things by DVS Media GmbH in trade journals, reference books and other publications and are therefore made accessible to the professional circles.

Dipl.-Ing. Jens Jerzembeck
Head of Research and Technology

Photo: Fotolia

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Brazing

The joining technology of brazing is one of the oldest, material-locking joining technologies of mankind. It is characterised by its diverse utilisation possibilities for the joining of metals, even of different types, and brazed joints can be found in all areas of everyday life. Due to new, modern brazing filler materials, procedures and processes, brazing technology also allows the manufacture of technologically demanding metal joints which permit innovative and pioneering products.

Without brazing technology, there would be, for example, no air conditioning systems in cars and no carbide tools available in any form. Even in the case of diffusion-tight gas piping, jewellery, tools or aircraft turbines, brazing makes an indispensable contribution to manufacturing products in a reproducible process and to being able to utilise them in a safe and reliable way.

The heating in the case of brazing is carried out by means of conventional flame, induction or resistance processes in batch or continuous furnaces in shielding gas or in a vacuum and can be implemented using highly innovative technologies such as laser and electron beams in the mass and single item fabrication of complex components.

Particular trends in the case of brazing can be found in the following fields:

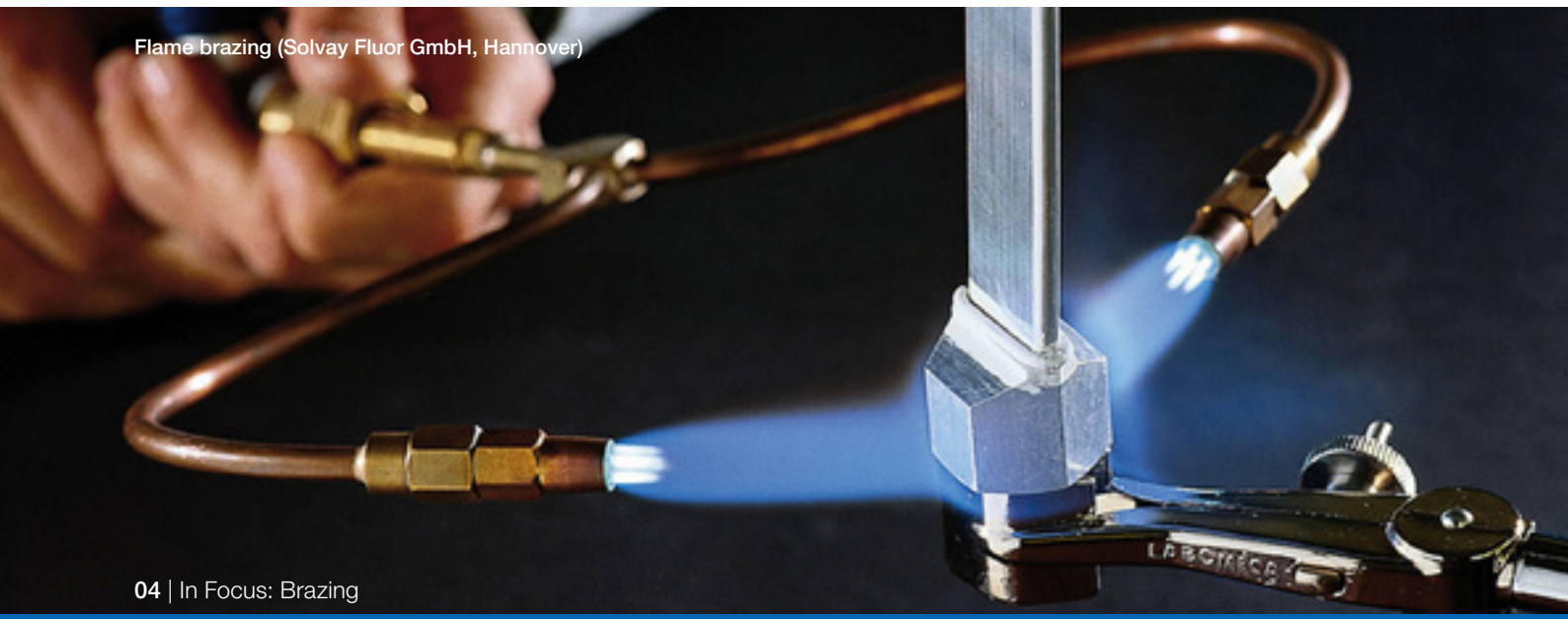
- development of low-melting brazing materials on an aluminium basis for the brazing of high-alloy and high-strength aluminium alloys
- application and development of corrosion-resistant iron-based alloys in the car exhaust cooler region as well as for pipes in the drinking water supply
- utilisation of modern application technologies such as screen printing and roller coating for brazing and high-temperature brazing pastes in mass fabrication
- investigation into the joining bond properties of the most diverse brazed joints

In this brochure, the extensive activities of DVS on the subject of “brazing” in the main focal points of research, technology and education are portrayed in a summarised form.

Dr.- Ing. Hartmut Schmoor,
Umicore AG & Co. KG, Hanau
Chairman of Specialist Society for “Brazing/Soldering”

Dipl.-Ing. Daniel Schnee,
Umicore AG & Co. KG, Hanau
Chairman of AG V6.1 “Brazing”

Dipl.-Ing. Ingo Reinkensmeier,
Siemens AG, Berlin
Chairman of FA 7 “Brazing/Soldering”



Flame brazing (Solvay Fluor GmbH, Hannover)

The Specialist Society for “Brazing/Soldering” in DVS

The Specialist Society for “Brazing/Soldering” offers its members the possibility of publicly effective self-portrayal to the outside. At the same time, it is a platform in order to competently represent the brazing technology interests in relation to the responsible institutions from the state and society in standardisation, in the field of personnel qualification as well as in other central areas.

The Specialist Society for “Brazing/Soldering” was founded in Düsseldorf on October 7, 1998 as the first specialist society in DVS. It has over 60 members from industrial companies, institutes and corporate bodies as well as private people.

The core element of the Specialist Society for “Brazing/Soldering” is essentially formed by the DVS organs and establishments dealing with brazing/soldering such as the working groups in the Technical Committee, the research committees in the Research Association on Welding and Allied Processes e. V. of the DVS and the expert groups in the Education Committee.

Benefits for members:

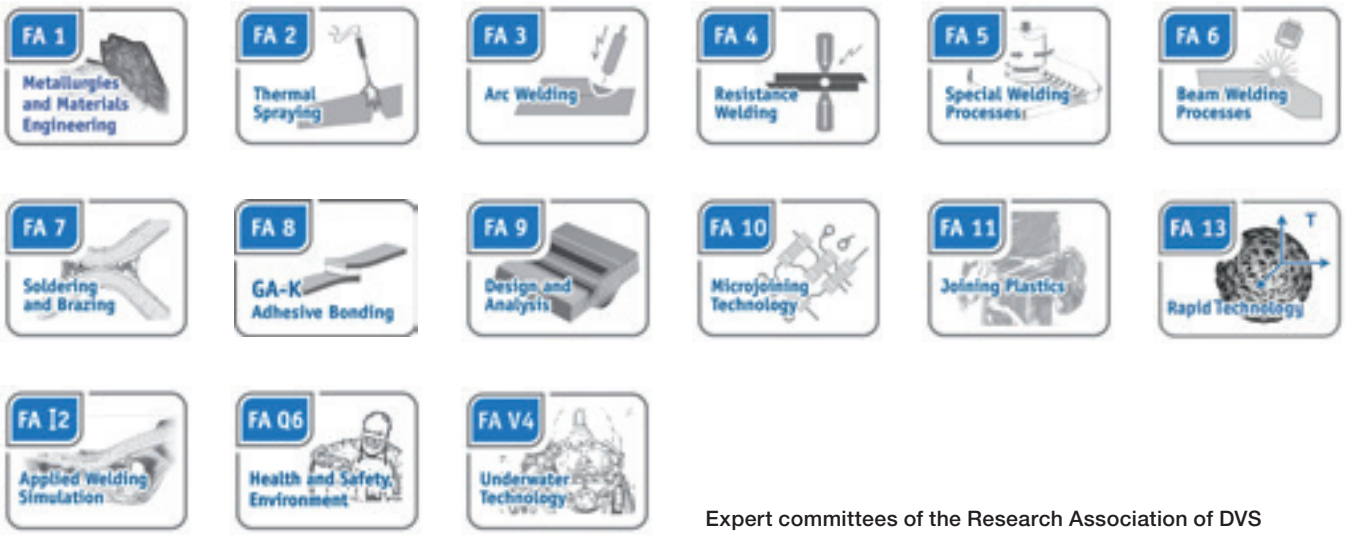
- regular, concise information on news related to brazing and soldering technology in the bi-annual INFO-SERVICE
- networking
- participation in the brazing-related panels of DVS in the Technical Committee, Education Committee and Research Association
- professional information and experience exchange with experts
- extensive discounts when attending DVS events and buying literature through DVS Media

Further information is available on the Internet at www.dvs-ev.de/loeten

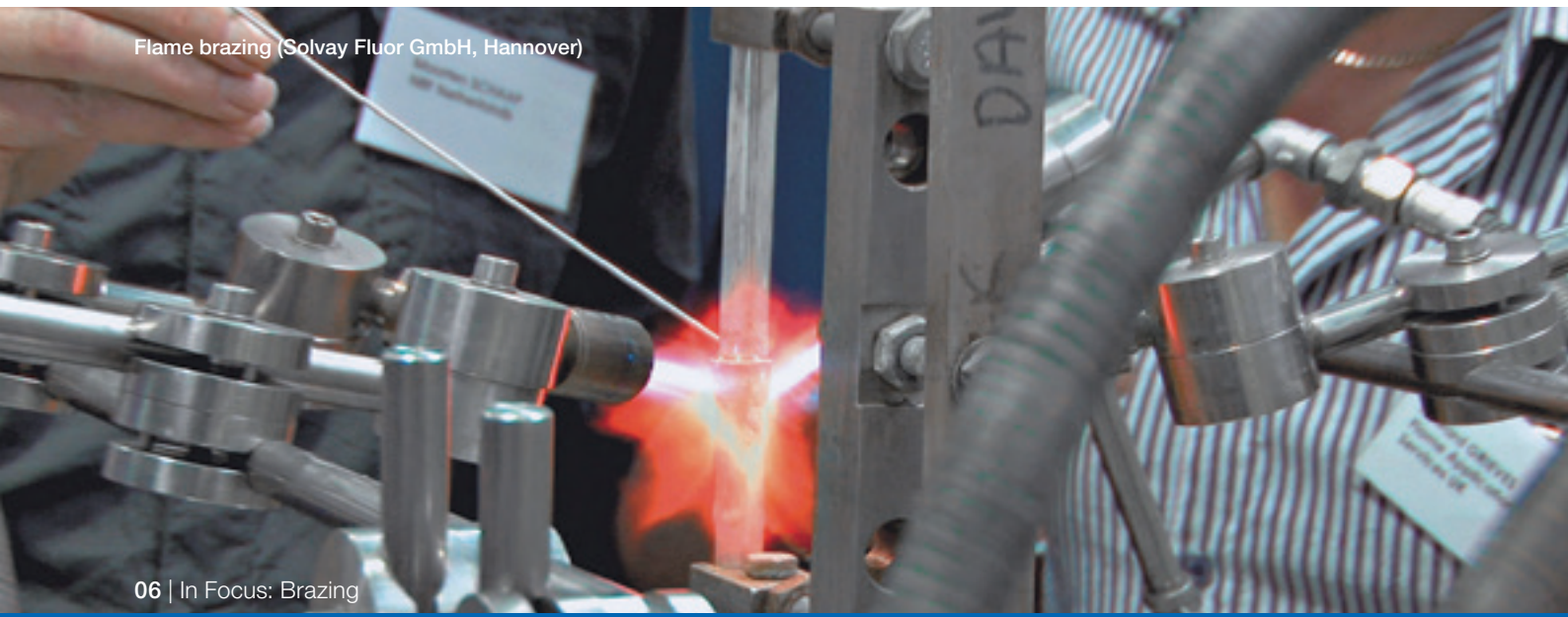
Research at DVS

The Research Association on Welding and Allied Processes e. V. of DVS

At the core of the Research Association on Welding and Allied Processes e. V. of DVS, there are the expert committees (FA). They are respectively assigned to a given department and as a result have a clearly defined thematic orientation. The functions of the expert committees are defined clearly: They are the interfaces assimilating the knowledge from enterprise, industry, trade and workmanship from the research centres, from the research association itself and from the DVS. Each of them contribute their own individual specialist knowledge to the work of the expert committees, something that means that practically oriented research projects and results can be guaranteed from the outset. This is because it is the task of the expert committees to derive research requirements within their respective specialist department and to communicate the results of the respective research. Therefore, the expert committees of the research association of the DVS are also involved in all phases of a given research project. They initiate and plan the projects, guide and control their implementation and finally evaluate the results.



Expert committees of the Research Association of DVS

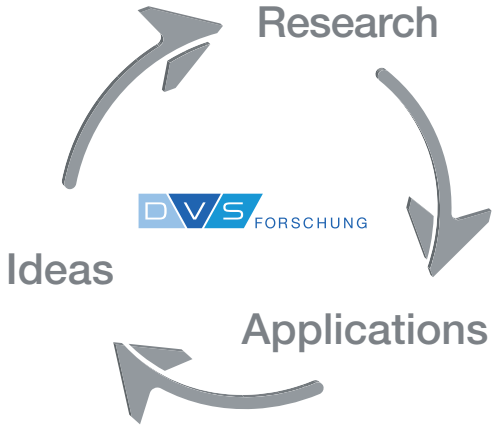


Flame brazing (Solvay Fluor GmbH, Hannover)

Cooperative industrial research

The core activity of the Research Association is the cooperative industrial research (IGF), which orients itself above all on the interests of small to medium-sized enterprises from the joining technology industry which frequently lack the means for own research activities. Via the IGF, it is possible to intercept these disadvantages that exist for structural reasons and to convert them into real competitive advantages because IGF combines the aspects of minimised economic risk with major research potential.

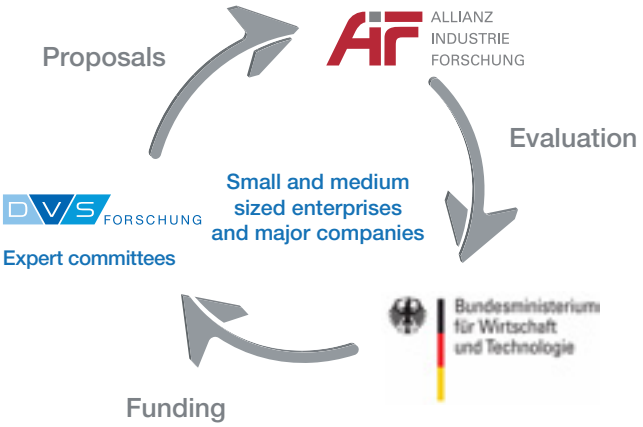
Core competence of the IGF is the close integration of theory and practice: Requirements that are formulated directly from operational practice form the basis for the research activities. In view of joining-related research, these requirements are announced within the individual expert committees of the research association. In the second step, the research priorities will be derived from this and these will be subsequently investigated by different research institutes in the form of research projects. Owing to the permanent communication with the expert committees and the active cooperation of enterprises going along with it during all the various phases, the aspect of a practically oriented research project always remains guaranteed. In addition, the cooperation of enterprises with the IGF gives rise to a swift knowledge transfer and hence also a parallelism of research and results exploitation. This is because the enterprises can investigate the initial results from the research directly for their practical usefulness and report their findings from this back to the research centres.



Research from practice for practical use:
The principle of the cooperative industrial research

The funding of the research projects takes place via the AiF – Federation of Industrial Research Associations "Otto von Guericke" e. V. from funds provided by the Federal Ministry of Economic Affairs and Technology (BMWi).

Partners and implementation of the cooperative industrial research



In this context, too, the expert committees of the research association assume important functions for they are the ones to decide which research projects are important for the joining industry and, hence, should be recommended for implementation. These research requirements are finally evaluated by a professional appraiser process of the AiF and, in the event of a positive decision, are recommended to the BMWi for implementation.

Given the complex processes within joining-based cooperative research, the interface functions of the expert committees within the research association manifest in a variety of ways. The way in which these expert committees perform their tasks, however, can be summarized under one umbrella heading: "Research from practice for practical use".

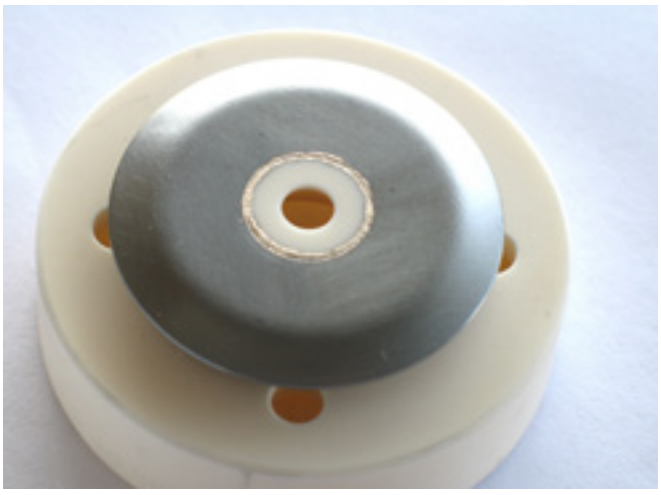
For more information and updates on the work of the Research Association on Welding and Allied Processes e. V. of DVS, please see: www.dvs-forschung.de

Expert Committee 7, “Brazing/Soldering”

An open communication between enterprises and research institutes identifies the approach in the expert committee “Brazing/Soldering” as a dedicated pool of ideas for research and application. There is also a very intense exchange of knowledge between the expert committee 7 and the topically related working groups V 6.1 “Brazing” and W 3 “Joining of Metal, Ceramic and Glass”. Through intensive collaboration, synergetic effects are created for research and technical advancement, for every aspect of the subject of “Brazing”.

In many industrial sectors, brazing technology has become a permanent constituent of joining technology. Flexible fabrication processes and process combinations exhibit a great potential for brazing technology with regard to the process developments and to the increase in the process certainty. In this respect, it is necessary to take account of questions relating to quality assurance and environmental protection in a particular way. The expert committee therefore conducts the research for the environmentally friendly processes (flux-free brazing and lead-free soldering) also in cooperation with other AiF research associations. It sees the necessity of setting up suitable advice and information systems with the objective of quickly transferring research results to the vocational qualification as well. Current research fields are as follows:

- brazing materials and brazing processes at low temperatures and with high strengths at the same time
- brazing technologies (laser beam, shielding gas, induction and resistance)
- application technologies (paste application, PVD, CVD, thermal spraying and electroplating)
- process development (reinforced brazing materials and metallisation)
- brazing of light metals (aluminium, magnesium and titanium)
- brazing of ceramics
- brazing of materials with extremely different coefficients of expansion
- substitutes for expensive alloying elements
- testing methods and quality assurance (online systems)
- failure behaviour / dynamic testing / non-destructive testing / reliability / service life predictability
- corrosion behaviour



Active-brazed focus electrode made of Al_2O_3 ceramic and tantalum (Listemann AG, Eschen/LI)

Specimen of an abrasive tool (Innobraze GmbH, Esslingen)

How applied research works – an example

Research Topic:

„Systematic investigation into the joining bond properties of brazed joints with test procedures relevant to the application II“

Research Centre:

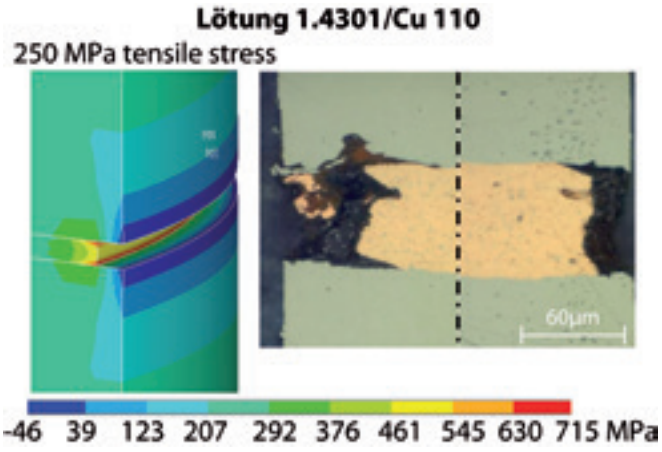
Lehrstuhl für Werkstofftechnologie LWT, TU Dortmund
Institut für Oberflächentechnik IOT, RWTH Aachen

Runtime: 01.05.2010 - 30.04.2012

IGF-No.: 16.558 N / **DVS-No.:** 07.062

In general, there is a lack in the field of brazing technology of dependable and transferable material properties, universal test methods and established simulation and modelling tools. Objective of the project was to determine dependable application data for select material combinations and to create the possibility – with a new modelling methodology – to be able to predict the mechanical loading capacity of brazed joints. Numerous material combinations of different industrial branches were analysed selectively and thoroughly. The influence on the mechanical behaviour and the contexts between the brazing materials and brazed joint properties and shearing thermal, dynamic as well as corrosive stress were examined. The results achieved allow to gain a better understanding of the determining factors must be considered in the design of such practically relevant brazing. A FE model was developed for the simulation of the brazed joints with different brazing defects under conditions of tensile stress. Different brazing defects according to DIN 18279 were implemented in the FE model that had been developed. Qualitative statements about the stress state of the brazed joints were supplied by the simulative calculation. To check the reliabilities of the FE model that had been developed, the simulated results were confronted with the experimental investigations with the help of two example cases and a very good correspondence was achieved. Through the success achieved, it has been shown that the resultant data, models and methods will allow the designers to be able to simulate brazed joints even under complex conditions. They serve to reduce the number of preliminary tests during the design of optimised joining point geometries and, hence, permit the use of brazing technology in areas where only competitive joining processes had been used up to now.

Simulation of additional localized load under mechanical stress resulting from corrosion damage on brazed joints



References from the industry

Dr.-Ing. Manfred Boretius, Managing Director, Listemann AG, Eschen, LI:
The use of brazing-based joining processes requires extensive knowledge about the resulting properties, above all concerning strength and corrosion resistance. In particular service providers, for time and costs reasons, are incapable to identify individual parameters for all applications that arise in practice. Against this background, the project delivers high quality insights that can be implemented directly into application. For Listemann AG, in particular, the results on brazed joints from hot work tool steel 1.2344 are significant. These materials are used with highly stressed injection moulding tools. Now, on the basis of the project results, we are able to improve in terms of customer advisory service, in particular when it is a matter of advising the designers, and to apply brazing technology for further, even more demanding applications. Hot runner manifolds for the plastics industry should be mentioned here, and mould inserts for aluminium die casting.

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Dr.-Ing. Harald Krappitz, Managing Director, Innobraze GmbH, Esslingen:
As a member of the Project Support Committee, we have been monitoring the progress of the abovementioned IGF project with great interest. We learn almost daily in our technical advisory function that the potentials of the brazing technology as a joining and coating method are still far from exhausted although it is the case that, for the utilisation of contemporary high-performance materials, it is precisely the brazing technology that could offer superior solutions. Often, the possibilities offered by brazing technology are not being used by the designers because the data to carry out an informative strength analysis as well as the possibility to perform reliable FEM calculations are available only to a very limited extent. Therefore, designers often shy away from the risk to provide brazed joints.

Through the results of the aforementioned research project, these doubts are counteracted directly in a double regard. On the one hand, data are provided from the results of the experimental works that will be able to be used directly in the design of joining bonds while, on the other hand, the comparison with the results of the FEM calculation provides evidence of the fact that the strength data obtained numerically have a good correspondence with the experimental results. The calculation of components by means of FEM, which is widespread in the industry, can be used therefore also for brazed joints.

The results of the conducted research project will be included in our technical documentation and will be used directly for the technical customer advisory service. We expect from this to be able to foster a higher level trust for this particular joining technology among designers and consider the results of the research project to be a valuable contribution to the prospect of opening up new application fields for brazing technology and therefore to also improve our own competitiveness. First signs of success in this regard have already been achieved.

You will find an overview of other ongoing or already concluded research projects at
www.dvs-forschung.de/forschungsergebnisse

Parts of the automotive industry – steel, brazed with Cu-paste (Innobraze GmbH, Esslingen)

DVS research seminar “Mobility as a driving force for new requirements for the joining technology – solution approaches involving brazing and high temperature brazing”

The DVS research seminar “Mobility as a driving force for new requirements for the joining technology – solution approaches involving brazing and high temperature brazing” was held between 12th to 13th of March at the Umicore & Co. KG at the Hanau location, with representatives from industry and research attending. It was an objective of the event to identify new topics that assist with meeting the requirements of the automotive sector, for future inclusion in the research roadmap of DVS. As a prelude event of what might in future become a series of research seminars on the specific application areas for brazing and high temperature brazing that will be taking place on a regular basis, a new event format was used here, involving the inclusion of the participants by means of brief impulse lectures, cooperative work and prioritisation of ideas by means of a voting technology based on clicks.

The first day was characterized by interactive work in fields of influence that were established by general requirements as well as automotive requirements as well as new technologies. In these fields, impulse lectures were held in each case by the representatives of the industry and the various institutes, concerning existing problem formulations and these were later discussed. Afterwards, challenges for brazing were discussed, broken down into the following areas: brazing processes, process development, brazing material, systems engineering, instrumentation and control engineering, testing methods and characteristic variables as well as modelling, calculation and simulation. Possible solution paths were discussed and, together, ideas were developed for future research subjects in both the general and automotive-based requirements areas:

- **Suitability for mass production**
  Joining processes in the automotive sector must be able to be performed a thousand times over and more, reproducibly and with consistent quality. Other priorities that determine the suitability for mass production include product unit cost and the scalability of the production or of the production structures.

- **Part variance and plant flexibility**
  Quick convertibility of the systems engineering, a modular product concept and modular systems engineering. The trend goes from tools with component contour to programmable path processes.

- **Efficient, robust manufacturing processes**
  Manufacturing processes that produce ok parts, even under fluctuating environmental conditions, the supply of sufficiently large process windows and construction knowledge and planning knowledge for robust manufacturing processes.

- **Quality assurance**
  Consistent component and functional testing (direct part allocation incl. documentation of the quality data!) and seamless process control, partly with possibility for (inline-) process control.

- **Service life durability**
  Guaranteed stability of assured properties across the term of the intended service life, fatigue strength of material composites and corrosion resistance.

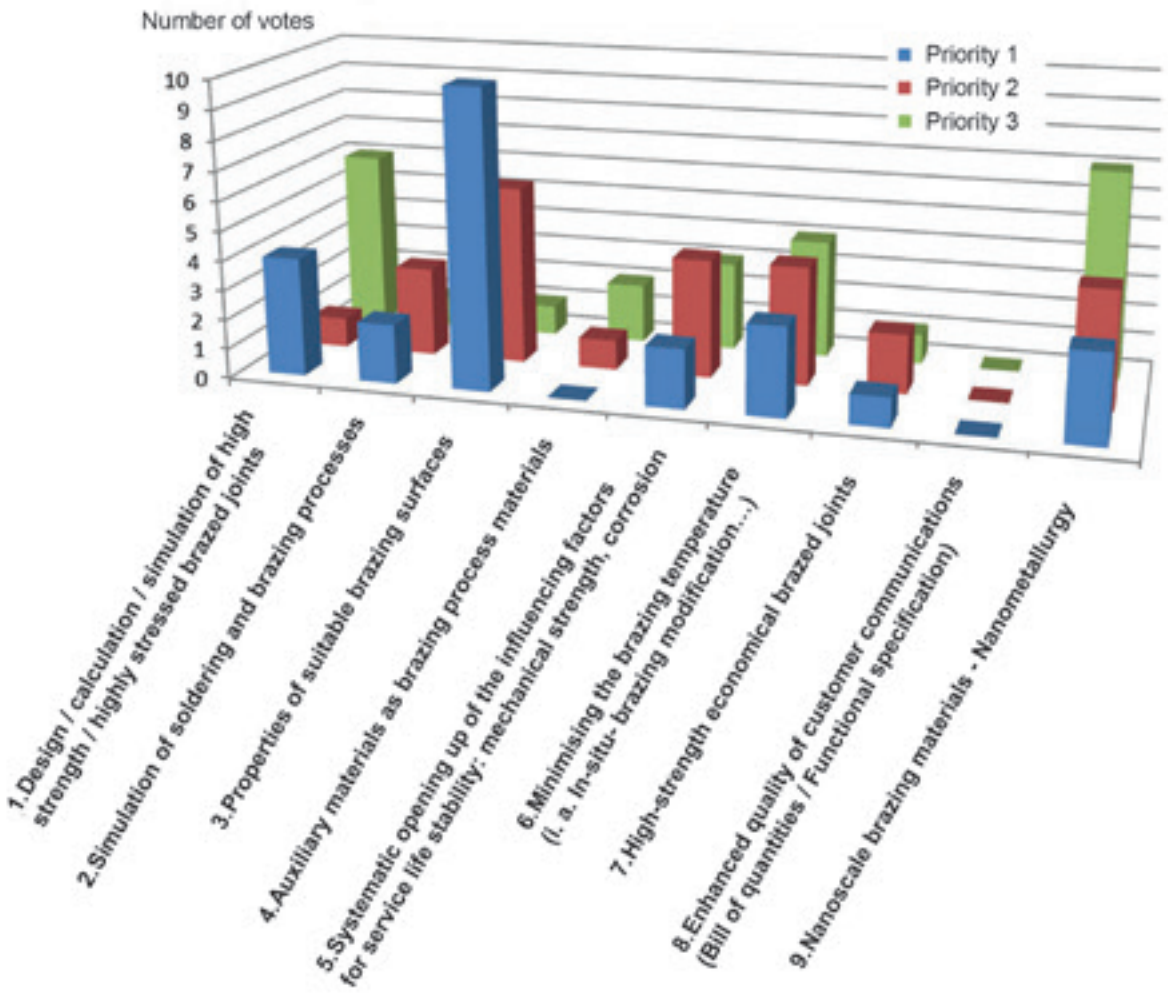
- **Lightweight construction and downsizing**
  Material thickness derating but still guarantee of assured strength. Multi-material systems have to be joined. More and more critical geometries occur due to small dimensions and sensors have to be integrated.

- **Design freedom and special functional properties**
  Joining bonds in Class A-surface quality, crack bridging, above all in the exposed areas and electric thermal conductivity.

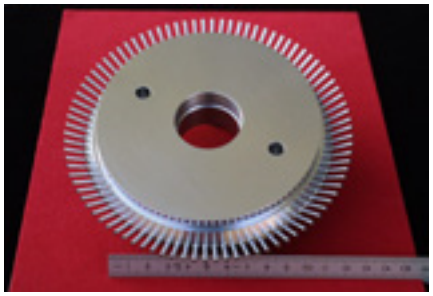
- **Energy efficiency and sustainability**
  Political and increasingly cost-based demand for energy efficient and materials efficient manufacturing processes.

- **Technical progress and new developments**
  New processes and procedures are made possible by fundamental new insights from basic sciences (physics, chemistry).

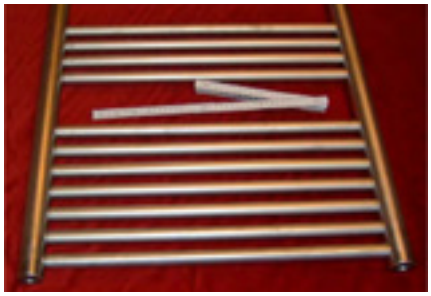
Triggered by the issue of nanoscale brazing materials, the question of addressing / support of basic subjects (DFG) has arisen within FA 7. Currently, AiF plans are predominantly funded. There is, however, the requirement to also be supported by FA 7 in basic subjects that are funded by DFG.



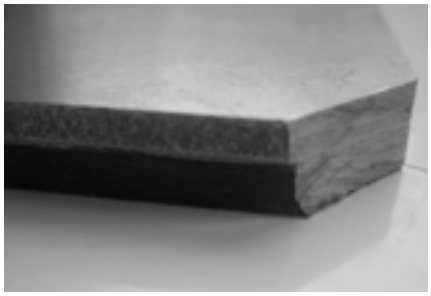
Application Examples



Analytics Manifold from pure titanium brazed with titanium base brazing material (Listemann AG, Eschen/LI)



Brazed bathroom radiator
(Innobraze GmbH, Esslingen)



Brazed composite sheet element
(Euromat GmbH, Baesweiler)

Flame brazing
(Solvay Fluor GmbH, Hannover)

Brazed wear and tear protective layer on peeling tool
(Euromat GmbH, Baesweiler)

Heat exchanger for trucks in module aluminium sheeting, CAB brazed
(Modine Europe GmbH, Filderstadt)

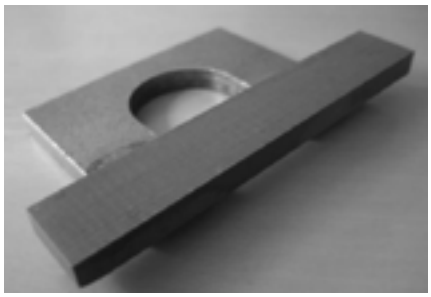
Aluminium- Heat exchanger
(Solvay Fluor GmbH, Hannover)

Welding and CAB brazing in heat exchangers, here truck charge air radiator and air conditioning capacitor
(Modine Europe GmbH, Filderstadt)

Brazed wear and tear protective layer on transport roller
(Euromat GmbH, Baesweiler)

Robust aluminium coolant cooler, CAB brazed, for use in construction machinery.
(Modine Europe GmbH, Filderstadt)

Exhaust gas heat exchanger made of stainless steel with nickel base brazing material, brazed in a vacuum, high temperature procedure (pattern)
(Modine Europe GmbH, Filderstadt



Brazed WC wearing strip
(Euromat GmbH, Baesweiler)

Technology at DVS

Technical Committee

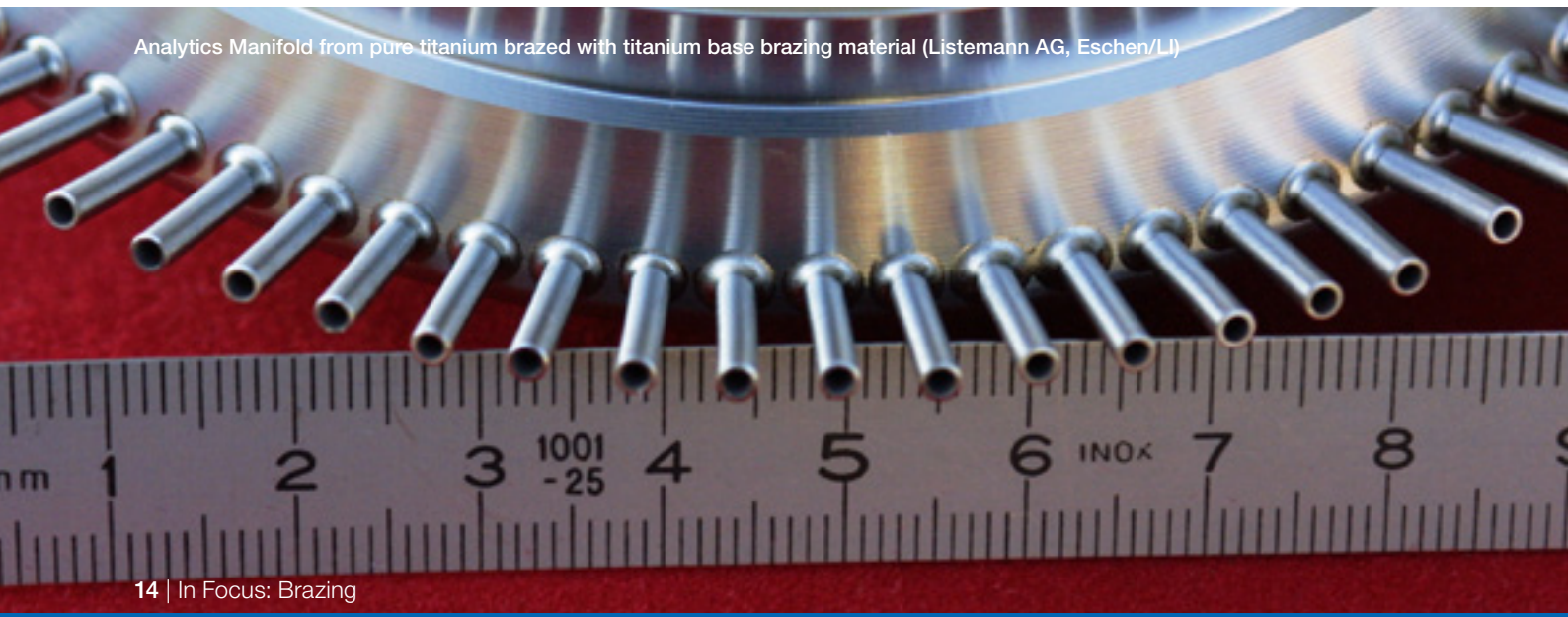
In view of currently more than 250 different joining processes, whose numbers continue to increase, the technical-scientific cooperative work of DVS can and must be done systematically. Guarantor for this is the Technical Committee (AfT) with its more than 200 subject-oriented working bodies. The AfT unites more than 2,000 specialists from the economic and scientific fields, from authorities and from other areas, that are working together to capture the state of the art and continuously advance it.
The fact that the DVS, with this bundled up specialist knowledge, is also recognized in international circles as a sovereign and competent partner in all questions relating to joining technology is obvious. Through its involvement in the International Institute of Welding (IIW) and the EWF - European Federation for Welding Joining and Cutting, the DVS decisively supports the international joining technology network in its activities.

International partners of the DVS:

DIN	German Institute for Standardization
CEN	European Standards Committee
ISO	International Standards Organisation
IIW	International Institute of Welding
DIBt	German Institute for Structural Engineering
VdTÜV	Federation of the Technical Inspection Associations
DVGW	German Association of the Gas and Water Industry
AGFW	Association for District Heating
AWS	American Welding Association
NIL	Dutch Welding Association
EWF	European Federation for Welding, Joining and Cutting

The work results in the AfT are published as DVS fact sheets and DVS guidelines. Besides, a close collaboration with other rule-making national and international institutions like the German Institute for Standardization, the CEN or others (see table) further ensures that the contents of the DVS fact sheets and DVS guidelines are sensibly coordinated with the rules and regulations of the other institutions.

DVS members benefit from free access to the German-version set of rules of the DVS at www.dvs-regelwerk.de. All technical DVS fact sheets and DVS guidelines of the association are retrievable there in electronic form



Analytics Manifold from pure titanium brazed with titanium base brazing material (Listemann AG, Eschen/LI)

Structure of the Technical Committee

Main Division W
Basic materials, filler materials and auxiliary materials

AG W 1 Technical gases	**AG W 2 **** Welding of cast materials	**AG W 3 **** Joining of metal, ceramic and glass	**AG W 4** Joining of plastics	**AG W 5 *** Welding consumables	**AG W 6 *** Welding of aluminium and other light metals

Main Division V
Processes and equipment

AG V 1 * Gas welding	**AG V 2 *** Arc welding	**AG V 3 *** Resistance welding	**AG V 4** Underwater engineering	**AG V 5 *** (Thermal) cutting

AG V 6.1 * Brazing **AG V 6.2 *** Soldering	**AG V 7 *** Thermal spraying and thermal sprayed layers	**AG V 8** Adhesive bonding	**AG V 9.1** Electron beam welding **AG V 9.2** Laser beam welding and allied processes	**AG V 10 **** Mechanical joining	**AG V 11*** Friction welding

Main Division Q
Quality management, design, calculation, health and safety

AG Q 1 Design and calculation	**AG Q 2*** Quality management for welding	**AG Q 4*** Testing of welds	**AG Q 5*** Demands on welding personnel	**AG Q 6** Health and safety and enviromental protection

Main Division I
Information

AG I 1 Information and communication technology	**AG I 2*** Application oriented welding simulation	**AG I 3** History of welding technology	**AG I 4 *** Illustration, terms and definitions

Main Division A
Applications

AG A 1 Welding in turbo machine building	**AG A 2** Joining in electronics and precision engineering	**AG A 5** Welding in construction settings	**AG A 6** Welding in shipbuild and marine engineering

AG A 7 Welding in railway vehicle manufacturing	**AG A 8** Joining in vehicle manufacturing	**AG A 9 *** welding in aviation and aerospace engineering

Specialist societies

Specialist society for "Brazing/Soldering"	**Specialist society SEMFIRA/EMF *****

AG: Working Group, * Joint Working Group with NAS (Standardisation Committee Welding and Allied Processes)
** Joint Working Group with other Societies, ***SEMFIRA = Safety in ElectroMagnetic Fields, EMF = Elektromagnetische Felder.

Working Group V 6.1 “Brazing”

Due to the optimisation of existing utilisation areas and the opening-up of an increasing number of new utilisation areas, ever more significance is being attached to brazing all over the world. Therefore, the utilisation possibilities of this joining process are far from having been exploited to the full also with regard to the ever more innovative material developments and the new joining tasks connected with these. This trend is being confirmed in an impressive way by the growing number of new material combinations joined with these processes.

DVS supports and promotes these traditional and pioneering joining processes in DVS Working Group V 6.1 “Brazing”. In close cooperation with Working Committee NA 092-00-26 AA “Brazing” in the standards committee „Welding and Allied Processes“ of DIN e. V., experts from leading renowned companies and research establishments meet up in order to exchange the latest knowledge and innovations in the field of brazing and high-temperature brazing and to incorporate them into and implement them in existing or new sets of rules such as DVS technical bulletins and technical codes or standards at the national, European and international levels.

The great significance of brazing and high-temperature brazing is also reflected by the internationally renowned colloquium on “Brazing, High-Temperature Brazing and Diffusion Welding” (LÖT) , which is staged by DVS in a three-year rhythm and receives decisive support from die DVS-AG V 6.1.

DVS-AG V 6.1 is composed of more than 50 specialists and experts working on an honorary basis

Working Group W 3, “Joining of metal, ceramic and glass”

Since 1972, Working Group W 3, with over 40 members, has been concerned with the joining technology for metal, ceramic and glass at the international level. Brazing plays a great role in this respect. The working group is a neutral forum in which specialists from industry, universities and large research establishments exchange their experience, define new research objectives and accompany research projects. Furthermore, standards, technical codes and technical bulletins are elaborated and round robin tests, which are intended to support the designer and the user in the designing and utilisation of material joints, are carried out. Competence which extends from the manufacture of the base materials right up to scientific analytical methods is bundled by the cooperative work: joining technologies for high-performance materials, development of brazing materials with tailor-made properties as well as understanding and optimisation of the interfacial reactions during joining processes. Interest naturally centres on the material combinations because of the great innovation potential. The community of interests in W 3 would like to bring this potential to the attention of the widest possible circle of users. The exchange of experience in the group is the top priority. The colloquium “Joining of Metal, Ceramic and Glass”, staged for the first time in 2009, has the objective of transporting the subject to a wider circle.

Working Group V 2.4.8 “Arc brazing”

Working Group V 2.4.8, with over 40 members, deals with arc brazing. This process is normally utilised on surface-refined thin sheet metal made of steel. Due to the low melting temperature of the brazing material (910 to 1,040°C), the coating is subjected to little damage and the components to low thermal loads.

The filler materials used are largely insensitive to corrosion. Arc brazing does not result in any substantial melting of the base material and no fluxes are usually necessary.

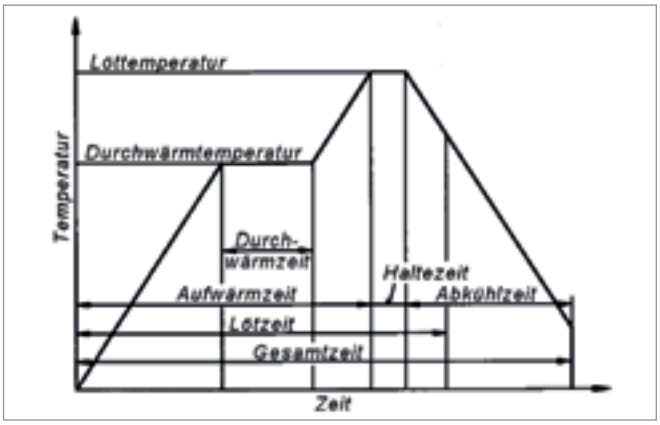
Gas-shielded metal-arc brazing differs from MIG or MAG welding because wire electrodes on a copper basis are used as the filler material. It can be utilised in the short-arc and pulsed-arc techniques in all positions. In the case of TIG brazing, brazing material in the form of a rod (manual) or a wire (mechanised) is guided into the arc. Preference should be given to the flat position and to vertical-down welds. Plasma-arc brazing is similar to TIG brazing. The arc is constricted additionally by a plasma nozzle and is thus provided with a higher energy density. This permits narrower welds and a higher brazing speed. In the case of the plasma-arc hot-wire process, additional energy is obtained by the resistance heating of the filler material. The brazing speed can be raised even further.

The practical relevance of the DVS set of rules – two examples

DVS technical bulletin 2607 "Process control during high-temperature brazing"

The DVS technical bulletin applies to the monitoring of the relevant parameters for the brazing procedure: furnace atmosphere, temperature and time. Requirement for a controlled brazing procedure is a suitable furnace system. Figure 1 shows the temperature-time diagram.

Figure 1: temperature-time diagram



DVS technical bulletin 2617 "Reclassification and labelling requirements for fluxes for brazing that contain boric acid, borax pentahydrate or di-boron trioxide"

Under the auspices of the United Nations, a Globally Harmonised System for Classification and Labelling of Chemicals (Globally Harmonised System of Classification and Labelling of Chemicals) – in brief GHS – has been developed, in order to remove differences in the existing international systems of classification and labelling of chemicals and to further increase the standard in safety at work, health protection, environmental protection and consumer protection as well as for the transport of hazardous goods.

This GHS system was introduced in the EU on 16.12.2008 with the EC Regulation No. 1272/2008, namely: Regulation on classification, labelling and packaging of substances and mixtures (Regulation on Classification, Labelling and Packaging of Substances and Mixtures) – CLP Regulation. The CLP Regulation entered into force on 20.01.2009 and applies throughout Europe ever since. The recommendations of the UN with their GHS system were not completely but largely adopted by the EU, Table 1 and 2.

Table 1. Time limits for labelling according to the CLP Ordinance

Etikett	alte Kennzeichnung	neue Kennzeichnung
Stoffe	erlaubt bis 1.12.2010 (Lagerbestände + 2 Jahre)	erlaubt ab 20.1.2009 zwingend ab 1.12.2010
Gemische	erlaubt bis 1.6.2015 (Lagerbestände + 2 Jahre)	erlaubt ab 20.1.2009 zwingend ab 1.6.2015
Sicherheitsdatenblatt		
Stoffe	zwingend bis 1.6.2015	erlaubt ab 20.1.2009 zwingend ab 1.12.2010
Gemische	zwingend bis 1.6.2015	erlaubt ab 20.1.2009 zwingend ab 1.6.2015
Im Sicherheitsdatenblatt muss die alte Einstufung ebenfalls bis 1.6.2015 aufgeführt sein.		

Table 2. Levels for the classification

Stoff	EG-Nummer	CAS-Nummer	Gehalt für die Einstufung
Borsäure	233-139-2 234-343-4	10043-35-3 11113-50-1	≥**5,5%**
di-Bortrioxid	215-125-8	1303-86-2	≥**3,1%**
di-Natriumtetraborat, wasserfrei	215-540-4 235-541-3 237-560-2	1330-43-4 12267-73-1 13840-56-7	≥**4,5%**
di-Natriumtetraborat-Decahydrat	215-540-4	1303-96-4	≥**8,5%**
di-Natriumtetraborat-Pentahydrat	215-540-4	12179-04-3	≥**6,5**

Education at DVS

Education Committee

The Education Committee (AfB) initiates measures to adapt the education and certification offering of the DVS to present developments and to prepare for future requirements. At the same time, the AfB acts as a guidance committee for the Personnel Certification Body DVS-PersZert and its activities. In this respect, the AfB assumes the role of a Strategy Committee. In this, it is being supported by the working group Training and Examination (AG SP).

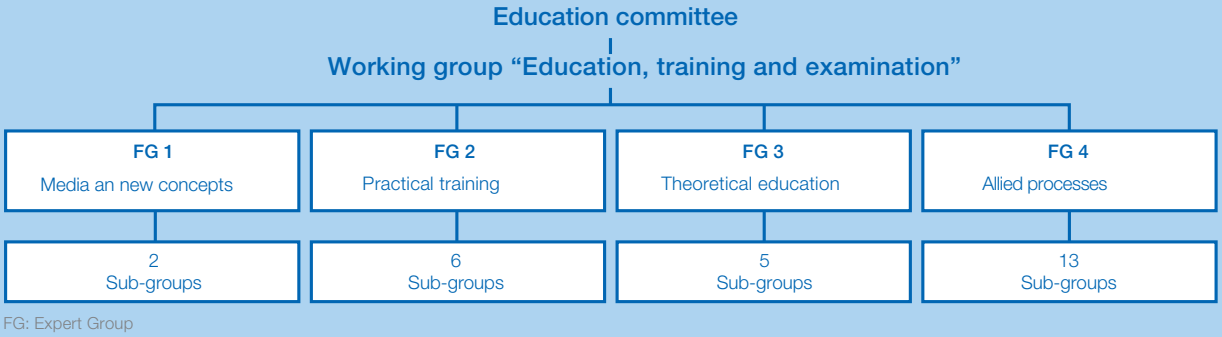
The working group Training and Examination assumes – in the "Education and Certification" area – the task of creating uniform training and testing material as part of the qualification of joining experts and managers. Thereby, national, but also current European and international requirements of the EWF – European Federation for Welding, Joining and Cutting or the International Institute for Welding (IIW) are implemented in the training and testing standards.

Because the AG SP equally considers the interests of industry and trade in its work, the needs of industry are directly reflected in the compiled Directives. The area of responsibility of the AG SP encompasses the development of the specific syllabuses and curriculums for joining-related education and training, in addition, however, also all other areas that are associated with the field of Training and Examination. The fact that these training and testing standards are ultimately truly complied with all over the country, and are actually also being implemented, is something that is ensured by the Personnel Certification Body of the DVS, DVS-PersZert.

Personnel qualification in DVS
Specialised groundwork in the training and examination area, with everything to do with brazing, is done by the expert committees 2.5 "Brazer" and 4.12 "MIG-brazing" (AG V 2.4.8). The expert committees deal with the development of Directives for qualification and examination of Brazers. As a further project, the installation of a brazing supervision is planned. For this training course, the first drafts are already present. The training and advanced training in the field of brazing is carried out according to DVS® Directives, only in DVS® educational facilities accredited by means of DVS-PersZert®.

Photo: Fotolia

Structure of the Education Committee



FG: Expert Group

Training and career paths in the field of brazing

DVS® 1182 “DVS course for manual arc brazing”

The DVS® training guideline provides information about the training for manual arc brazing. The training encompasses a course with a specialist theoretical part and a practical part. The course ends with a qualification test. In this respect, the manual skills are proven by assessing all the qualification test tasks and the theoretical knowledge is proven by test questions.

DVS®-1183 “DVS course for the brazing of metallic materials”

The DVS® course for the brazing of metallic materials imparts the practical and theoretical fundamentals for brazing. Depending on the respective materials, the technological peculiarities are dealt with in Parts 1 and 2 of this guideline. Part 1 includes the brazing of copper materials and Part 2 the weld brazing of galvanised steel materials. The course is suitable for the training of specialists in the specified joining process and ends with a brazer qualification test according to DIN EN ISO 13585. The areas of application for taking a brazer qualification test are also governed in the standard. The course encompasses practical and theoretical training.

Guideline DVS 1182 “DVS course for manual arc brazing”, Issue July 2008

Guideline DVS 1183 “DVS course for the brazing of metallic materials”, Issue May 2004

Trade media and teaching materials for brazing

DVS Media GmbH

When it comes to publications and press relating to all aspects of the subject of joining, cutting and coating, DVS Media GmbH is the right place to go. The programme of the publishing house includes German and foreign language trade journals, specialist books, teaching media, technical bulletins and directives, videos and software. The products of DVS Media GmbH reflect all fields of activity of the DVS Association and all findings that have been worked out there.

Numerous professional media of DVS Media GmbH devote themselves to the work results that have originated in the areas of research, technology and education in connection with the brazing: This includes Specialist books and trade journals, as well as training materials and DVS directives, available individually or collected as a paperback.

How to get DVS fact sheets and DVS guidelines

DVS members have free access to all DVS fact sheets and DVS guidelines at www.dvs-regelwerk.de.
Non-DVS members can order the DVS set of rules under www.dvs-media.info

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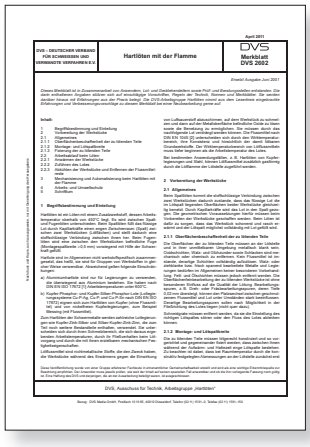
Photo: istockphoto

Publications on brazing

Brazing - An Introduction

Not only the growing need for brazing-based knowledge but also the fact that an availability of fundamental information constitutes the first important step to make the potential and significance of the brazing accessible to a wider range of user has caused a group of experts within the working group V 6.1 **"Brazing"** in the Technical Committee of the DVS to compile this basis presentation on brazing. It serves as training material for education and advanced training as well as an introduction to brazing technology for independent study. (Only in German)

1st edition 2010
144 pages, 85 images, 5 Tab. /14 DVS-Technical Bulletins, Softcover
ISBN: 978-3-87155-839-9



DVS technical bulletin 2602 Brazing with the flame

This DVS technical bulletin provides a summary on brazing with the flame, starting with the preparation of the workpieces, through the surface characteristics of the parts to be brazed, up to the assembly and brazing gap width and the fixation of the parts to be brazed, and including the workflows as well as information on occupational safety and environmental protection. (Only in German)

Further DVS technical bulletins on the subject are available at www.dvs-regelwerk.de

DVS 2602, April 2011 (replaces Issue December 2000)

DIN/DVS Pocket Book 196/1 Welding technology 5: Brazing

This DIN/DVS Pocket Book is an important reference book for correct brazing-related action, which should be used as an aid and for their benefit by trainees, designers manufacturing planning engineers, operators as well as office employees. With 20 printed standards and 6 DVS technical bulletins from the field of brazing, a current overview of generic standards in the field is provided. (Only in German)

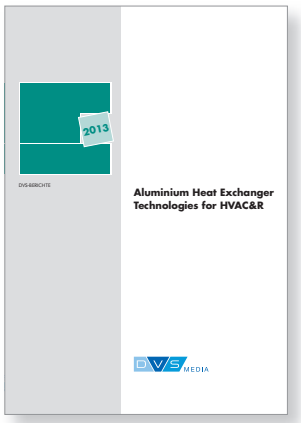
2nd edition 2013 (September)
approx. 260 pages, A5, Softcover,
ISBN: 978-3-87155-985-3

DVS-Berichte Band 293
Brazing, High Temperature Brazing and Diffusion Bonding
LÖT 2013

DVS-Berichte Band 293 contains the lectures and posters in form of manuscripts of the conference "Brazing, High Temperature Brazing and Diffusion Bonding" taking place in Aachen on 18th to 20th June 2013. This year's main subjects mirror the great interest of the experts in this conference which is of great importance for this branch: Applications, Processes, Materials, Properties.

The program commission has paid particular attention to the balance of scientific papers and industrial application when putting together the program. The main aim was to structure the exchange of information between both in such a way that the benefit for the user would always be the most important aspect.

318 pages, Softcover, DIN A4
ISBN: 978-3-87155-611-1
published Juni 2013

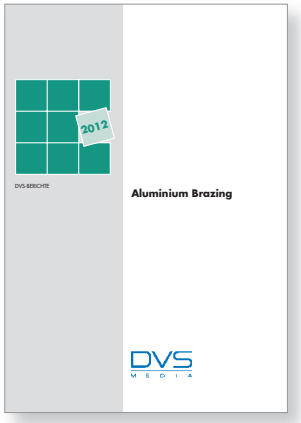


DVS-Berichte Band 297
Aluminium Heat Exchanger Technologies for HVAC&R

Lectures of the 3rd International Congress taking place in Düsseldorf on 15 to 16 May 2013.

Not only with regard to the climate change it is becoming more important to use energy efficiently and reduce emissions. Stringent environmental requirements are the greatest challenges the heating, ventilation, air conditioning and refrigeration industry faces. This international congress is dedicated to these aspects.

90 pages, Softcover, DIN A4
ISBN: 978-3-87155-616-6
published: May 2013



DVS-Berichte Band 289
Aluminium Brazing

Lectures of the 7th International Congress taking place in Düsseldorf on 22 to 24 May 2012. Main topics are: Materials, Applications, Equipment, Process and Quality Control and Testing

194 pages, 591 figures / 64 tables
ISBN: 978-3-87155-596-1
published: May 2012

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www.dvs-forschung.de

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www.dvs-forschung.de/fa07

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- Because you will actively participate in shaping technology fields.
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- Because you can identify trends early on.
- Because you can benefit from important national and international contacts.

Become a part of our network of over **3,000 companies** and **16,000 professionals** who are associated with the joining technology.

Please contact us!

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