



# CARE TO THE FINEST DETAIL

## INNOVATION

The VPE engineering team encourages exploration and experimentation, always striving to be leaders of metallurgical innovation. It is clear that VPE is at the vanguard of technological creativity in the fields of joining/bonding, specialized coatings, advanced thermal processing and unique assembly methods.


VPE is a model of planned growth with objectives of high quality, technological leadership and fair profitability. A strong research and development initiative has helped VPE stay on top of its industry and positions the company for continued success.

CUTTING EDGE.  
CREATIVE. COST-EFFECTIVE.




With Meticulous Attention to Detail VPE Specializes in:

- Vacuum brazing
- Diffusion bonding
- Hydrogen brazing
- Induction brazing
- Microchannel device fabrication
- Vacuum bake-out
- Turnkey production
- Thin film coatings
- Helium leak detection
- Process development
- Critical product heat treating




VACUUM PROCESS ENGINEERING





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VACUUM PROCESS ENGINEERING



PRECISION THERMAL PROCESSING  
WE CARE ABOUT DETAIL



*PRECISION THERMAL PROCESSING*

Since 1976, Vacuum Process Engineering (VPE) has offered high caliber, science and engineering-based thermal processing services. Capabilities include precision brazing, diffusion bonding, critical heating treating, thin film coatings and other specialized assembly and materials joining processes.



VPE's experienced staff can tackle any project with vision and unmatched technical excellence whether it's research and development work, large-capacity production or complete turnkey fabrication. We have over 35 years of experience in applied materials science, problem analysis, production methodology and design-for-fabrication.



*EXCELLENCE*

Our people believe that striving to be the best in their work, their relationships, their ideas and practices is the best demonstration of VPE's commitment to customer satisfaction. They expect to be held accountable and to hold others accountable for the best results.

VPE uses and develops the latest state-of-the-art technologies to guarantee the highest performance possible. VPE is deeply committed to providing the highest quality products and services and consistently strives to understand and exceed the requirements of its customers. With an unwavering commitment to precision performance, VPE will continue to build customer trust and loyalty. VPE provides world-class products and services that enhance customer satisfaction -- every day.

VPE HAS  
ONLY  
ONE STANDARD:  
*EXCELLENCE  
EVERYDAY*

*INTEGRITY*

People with Values

VPE seeks to build long-term relationships with its customers and its suppliers by being open and fair, accepting responsibility and by keeping its promises. At the core of VPE are values of sound communication and treating each other with respect and courtesy. It employs people who follow through with their commitments

and hold themselves accountable to achieve results. Staff members share information, provide feedback and genuinely listen to each other. Recognizing that attitudes are contagious, VPE aims to maintain a positive attitude and give others the benefit of the doubt and while taking scrupulous pride in its work.

*ASSURANCE*

Standards & Certifications

Company philosophy demands, and VPE verifies through inspection, that every product and service exceed compliance and industry standards. Its robust quality assurance program has been accepted by the most discriminating of corporations, national laboratories and independent auditors.

As a result, VPE has a proud history of meeting and acquiring the quality certification demands of the market.

To view VPE's  
current compliance  
certificates,  
visit [www.vpei.com](http://www.vpei.com)





# DIFFUSION BONDING



Based on High Temperature,  
Materials Science and Extensive  
Production Experience

In diffusion bonding parent materials are positioned together under an applied force and heated in vacuum, causing atoms from each part to diffuse across and finally eliminate the original interface. Dynamic loads to one million pounds, temperatures greater than 1500C and closely controlled furnace dwell times are utilized. With TLP (Transient Liquid Phase) bonding, an extremely thin "activation layer" is used to create a short-lived liquid interface at the parent materials being joined.



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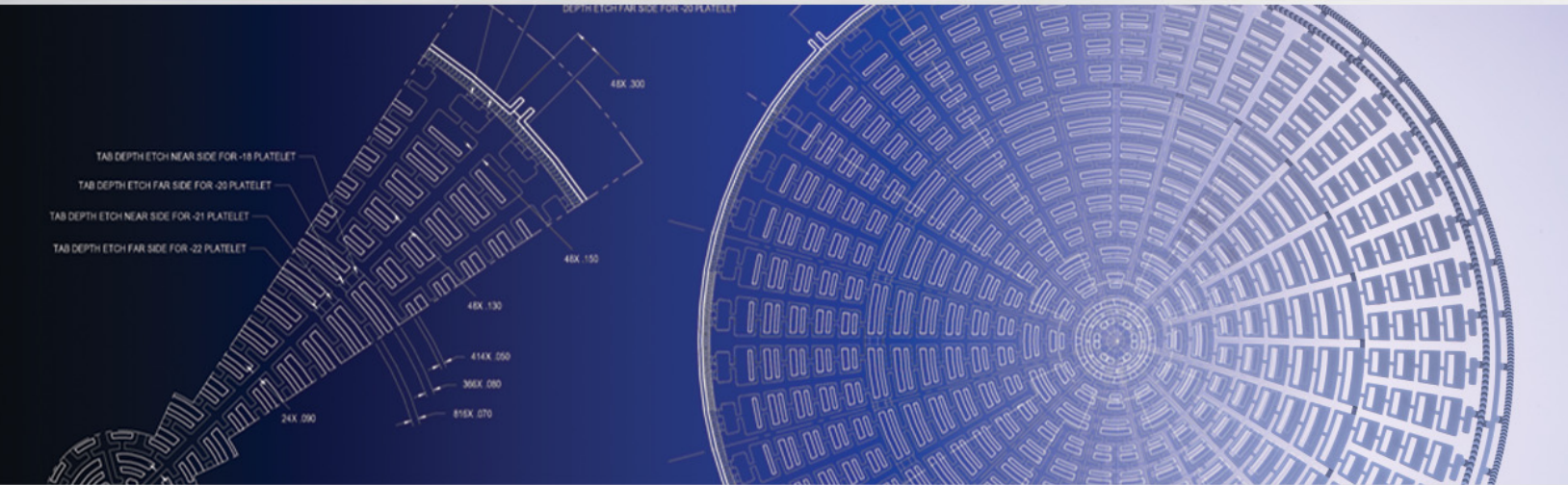
Several diffusion bonding techniques have been developed as VPE specialties since the company started in 1976. VPE has always been the most experienced and the best equipped commercial facility in North America for these processes. VPE's cost efficient diffusion bonding processes address critical parameters.

- CRITICAL DIFFUSION BONDING PARAMETERS
- Temperature profile design
  - Interfacial features
  - Component flatness
  - Surface roughness
  - Surface chemistry
  - and metallurgy

- Load application profile
  - Suitability of product design for bonding
  - Service environment
  - Strain-based processing
  - Production tooling design

- EXAMPLE DIFFUSION BONDING APPLICATIONS
- NASA – bonding parameter development for mars lander
  - Aerojet – space shuttle valve assemblies
  - Schilling - robotic assemblies for submarines used in offshore oil industry
  - Major medical device corporation – artificial heart implant components
  - Microchannel devices for fuel cells, reactors, reformers and heat exchangers

- OTHER JOINING PROCESSES
- Precision brazing
  - Electroforming
  - Low temperature hermetic sealing
  - Press seals
  - Thin film coatings
  - Hermetic ceramic-to-metal seals
  - Soldering



Assembly weights to 10,000 pounds, sizes up to 52 inches in diameter and parent materials as thin as 0.0002 inches are bonded routinely.

- PARENT MATERIAL CAPABILITIES
- Copper
  - Glidcop™
  - Nickel
  - Inconel™ alloys
  - Haynes™ alloys
  - Stainless steel
  - Aluminum

- Molybdenum
  - Titanium
  - Aluminum oxide
  - Magnesium
  - Platinum
  - Silver
  - Gold

- VPE'S DIFFUSION BONDING PROCESS CAPABILITIES
- Vacuum-based
  - Induction-based
  - Controlled atmosphere
  - Transient Liquid Phase (TLP)
  - Low temperature
- Long cycle, minimal strain
  - High production
  - Reactive interface
  - Interface-assisted

OVERALL CAPABILITIES OF VPE

- Contract R&D, prototyping, and turnkey product design and production
- ISO 9001-2008 certified manufacturing and processing services

- Many joining processes, including precision brazing and vacuum baking
- Thin film coating, heat treating, comprehensive analysis and testing lab





# PRECISION BRAZING



Based on Strong Materials  
Science Expertise and  
Long Production Experience

VPE has been continually developing and optimizing precision brazing processes since the company was founded in 1976. Our reputation for brazing excellence has come from applying strong engineering solutions and project management skills to complete many challenging R&D projects and to provide long-term volume production runs for critical applications.



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Successful precision brazing results in lower production costs, higher production yields and more robust end-use performance. For VPE, precision brazing means using a materials science-based approach to ensure that the process parameters are correctly designed and implemented.

PRECISION BRAZING PROCESSES PERFORMED BY VPE INCLUDE

- Vacuum
- Induction
- Hydrogen
- Aluminum
- Retort
- Controlled dewpoint
- Diffusion
- Pressure assisted
- Ultra fast
- Quartz lamp
- Controlled atmosphere

PARENT MATERIALS BRAZED BY VPE INCLUDE

- |                   |                   |                    |                    |                      |
|-------------------|-------------------|--------------------|--------------------|----------------------|
| • Copper          | • Invar™ alloys   | • Tungsten         | • Composites       | • Silver             |
| • Glidcop™        | • Havar™          | • Tantalum         | • Tungsten carbide | • Reactive materials |
| • Aluminum        | • Haynes alloys   | • Titanium         | • Vanadium         |                      |
| • Nickel          | • Stainless steel | • Ceramics         | • Rhenium          |                      |
| • Inconel™ alloys | • Aluminum        | • Aluminum oxide   | • Platinum         |                      |
| • Kovar™          | • Molybdenum      | • Aluminum nitride |                    |                      |



OTHER JOINING PROCESSES UTILIZED BY VPE

- |  |               |
|--|---------------|
| • Diffusion bonding                    | • Press seals |
| • Transient Liquid Phase (TLP) bonding | • Thin film   |
| • Electroforming                       | • Solder      |
| • Low temperature                      | • Hermetic    |

OVERALL CAPABILITIES OF VPE

- Contract R&D, prototyping, turnkey product design
- ISO 9001-2008 certified manufacturing and processing services
- Many joining processes, including diffusion bonding and vacuum baking
- Thin film coating, heat treating, comprehensive analysis and testing lab, clean room processing

EXAMPLES OF PRECISION BRAZING APPLICATIONS

- NASA – space exploration and lander programs
- Aerojet – rocket thruster nozzles
- Major aerospace contractor – engine fire sensors
- Major medical device corporation – ceramic-to-metal heater assemblies
- Fortune 10 corporation – reactor and gas turbine components
- Several markets – microchannel devices such as heat exchangers

CRITICAL PROCESS PARAMETERS FOR PRECISION BRAZING INCLUDE

- Joint design
- Joint volume control
- Temperature profile design
- Selective enabling or limiting capillary action
- Interface chemistry
- Filler alloy metallurgy
- Service environment
- Production tooling design

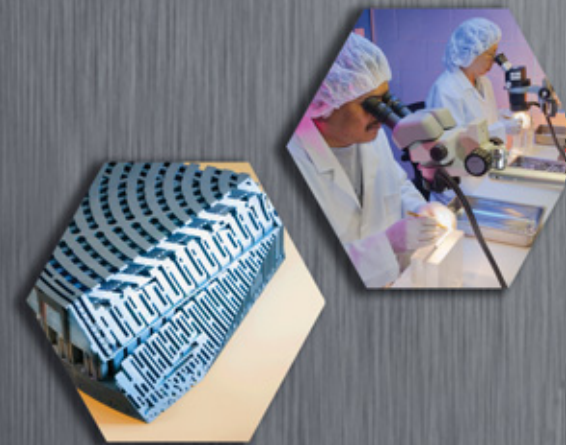




# PRODUCTION



## From Specific Tasks to Turnkey Long-Term Production



### Range of Production Services

- High volume, medium and low volume production and fabrication
- Specific process or assembly tasks
- Problem solving - product design and production issues
- Testing, analysis and quality assurance
- Material and subcontractor sourcing, qualifying and supervision
- Design and set up of production line with all tooling
- Production equipment development
- Turnkey product design, prototyping and production
- Turnkey production from drawings and specifications

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A UNIQUE COMBINATION OF CAPABILITIES

- Metallurgical expertise for both R&D and production
- Production-oriented for efficiency, low costs and high quality
- Highly efficient use of R&D and prototyping budgets
- Processes, parts, assemblies, complete products
- One-off to volume production
- Advanced testing and analysis equipment
- ISO 9001-2008, plus customer-specific QA standards
- Well qualified materials suppliers & subcontractors

QUALITY ASSURANCE

- ISO 9001-2008 certified
- Extensive in-house capabilities for production, testing and analysis
- Meet many exacting certification requirements, specific to applications or customers:
  - Medical
  - Aerospace
  - Electronics
  - Nuclear
  - Defense
  - Energy

EXPERTISE AND TRACK RECORD

- Reputation as solver of difficult problems and as a long-term, high quality and reliable production supplier
- People – project management specialists; materials scientists; materials, mechanical and electrical engineers; specialized technologists and experienced assembly and test personnel
- Many specialized suppliers and subcontractors
- Track record since 1976 with high customer retention

PRODUCTION FOR DEMANDING SPECIFICATIONS AND MISSION-CRITICAL APPLICATIONS

- Aerojet – reactive metal thermal processing
- Schilling - robotic assemblies for submarines used in offshore oil industry
- NASA – space exploration and lander programs
- Major aerospace contractor – engine fire sensors
- Major medical device corporation – ceramic-to-metal heater assemblies
- Fortune 10 corporation – homeland security assemblies



OVERALL CAPABILITIES OF VPE

- Contract production of critical assemblies
- Contract R&D, prototyping, turnkey product design
- Many joining processes, including precision brazing and diffusion bonding
- Thin film coating, heat treating, comprehensive analysis and testing lab
- ISO 9001-2008 certified manufacturing and processing services

PROCESSES, EQUIPMENT, FACILITIES

- Brazing furnaces for: vacuum, partial pressure, hydrogen and argon
- Systems and furnaces for diffusion bonding and induction brazing
- Thin film coating by electron beam, ion plating, sputtering
- Heat treating – many specialized processes
- GTAW welding and capacitor welding stations
- Cleanrooms, cleaning cells, flow benches
- Metallurgical testing and analysis
- Wet lab, metrology, variety of inspection equipment
- 60,000 sq ft of design, lab, QA and production space







## Highly Efficient Use of R&D and Prototyping Budgets



### VPE Technical Specialties

- Processes for metal joining, thin film coating, heat treating and fabrication
- Design of experiments – for processes and assembly fabrication
- Assemblies and devices having high temperature applications
- Use of and joining of exotic metals and ceramics
- Brazing – vacuum, hydrogen, induction, fast ramp heating
- Diffusion bonding, TLP (Transient Liquid Phase) bonding
- Design for efficiency and quality in production
  - Complex assembly techniques and fixturing
  - Microchannel device processing and assembly
- Testing and analysis

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- Systems and furnaces for diffusion bonding and induction brazing
- Thin film coating by electron beam, ion plating, and sputtering
- Heat treating – many specialized processes
- Techniques for fabrication of complex fixturing and assemblies
- GTAW welding and capacitor welding stations
- Cleanrooms, cleaning cells, flow benches
- Metallurgical testing and analysis
- Wet lab, metrology, variety of inspection equipment
- 60,000 sq ft of design, lab, QA and production space

IN-HOUSE TESTING AND ANALYSIS SERVICES

- Advanced testing and analysis services to support both in-house R&D and production QA and also offered as an external service to customers
- ISO 9001-2008 certified
- Examples
  - Metallography
  - laboratory analysis
  - Residual gas analysis
  - Helium leak detection
  - Pressure testing
  - Strength of materials
  - Failure analysis

WORKING WITH VPE

- Minimize R&D, prototyping, production costs, and time-to-market through innovation
- In-house metallurgical expertise to solve difficult problems as they arise
- Complete solutions – using both in-house resources and well qualified subcontractors
- Contract flexibility - from cost-plus to partnering
- Highly responsive technical interaction with prospects and customers – engineer-to-engineer



OVERALL CAPABILITIES OF VPE

- Contract R&D, prototyping, and turnkey product design
- ISO 9001-2008 certified manufacturing and processing services

- Many joining processes, including precision brazing and diffusion bonding
- Thin film coating, heat treating, comprehensive analysis and testing lab

RANGE OF R&D SERVICES

- Component, subassembly or turnkey product development
- Contract research services
- R&D preceding production by either customer or by VPE
- Prototyping, proof-of-concept demonstrations
- Design of Experiment (DOE)
- Specific process development or problem solving
- Technology transfer programs
- Production equipment, production line development
- Complete R&D solutions using both in-house and subcontractor expertise

R&D FOR DEMANDING CUSTOMERS AND MISSION-CRITICAL APPLICATIONS

- Fortune 50 conglomerate – development of implantable battery seals
- Aerojet – development of cleaning processes for reactive metals
- LLNL – development of pulse purge cleaning technology
- GE – development of a ruggedized sapphire window for harsh environments

