Making advanced materials affordable...
Transition45 Technologies, Inc. (T45) is a high technology business focused on the development and application of advanced metallic materials and manufacturing technologies of critical importance to the Nation’s future.

CORPORATE OVERVIEW

T45 engages in the innovation and advancement of processing, characterization, and life management methods that will allow for the successful implementation and safe use of advanced metallic materials and structures. Our team of experienced engineers, scientists, and technical experts combine a strong foundation in Metallurgy, Materials Science, Engineering, and computational simulation with practical, hands-on manufacturing know-how and proprietary in-house processes to create new technologies that will enable advanced materials and structures to be designed and affordably produced. These processes can then be used to produce components in-house or be licensed for use/production by partners/customers.

TECHNOLOGY

The T45 team has extensive technical expertise and real world production experience developing and working with a broad range of materials and materials processing technologies including:

- Master Alloys of Unique and Specialty Alloys
- Melting and Net/Near-Net Shape Forming (e.g., investment casting, hot die isothermal forging, superplastic forming, and powder metallurgy)
- Rapid Prototyping and Tool-Less Manufacturing
- Cellular Materials and Structures
- Surface and Microstructural Modification
- Welding and Joining
- Spray Coating
- Computational Simulation and Finite Element Analysis
- Design For Six Sigma (DFSS) and Manufacturing For Design (MFD)
- Life Management and Damage Tolerance Methodologies
**RESEARCH AND DEVELOPMENT**

T45 actively collaborates/partners with the government, primes, other businesses of all sizes, and non-profit research institutions and universities through Small Business Innovative Research (SBIR)/Technology Transfer (STTR) and other funding programs. Collaborative programs are typically high intellectual and interdisciplinary activities that maximize the strengths of the government-small business-end user partnership to achieve an innovation that will benefit diverse industries in the country, ranging from aerospace and defense to industrial and consumer products. For example, through a NASA SBIR Phase 2 program, T45 engineers developed the first ever aerospace quality titanium alloy lattice block structures. These ultra lightweight engineered materials are now being evaluated by the Navy, Army, and others as lightweight, damage tolerant structures. A number of these projects may also integrate research and education by providing opportunities for undergraduate and graduate engineering students such as through detailed studies on the processing-microstructure-mechanical property relationships in advanced materials.

![Image](image_url)

**REPRESENTATIVE PROJECTS**

- Design and fabrication of lightweight, corrosion resistant titanium topside structures for unmanned naval sea surface vessels (Navy).
- Manufacture of bulk size high density reactive materials structures with targeted energetic properties using an inexpensive, scalable, and high volume capable fabrication processes (Navy).
- Evaluation of superalloy lattice block structures as higher performance leading edges and control surfaces for surface-to-air interceptors used for sea-based ballistic missile defense systems (Navy).
- Development of robust ring rolling technology for production of aluminum-based metal matrix composites bearing liners for rotorcraft (Navy).
- Advancement of casting and forging technologies for near-net shape components of higher performance titanium alloys such as Ti-5Al-5Mo-5V-3Cr for use in naval and land-based weapon systems (Navy, Army).
- Fabrication of titanium lattice block structures for testing as lightweight, blast-resistant structures for combat vehicles (Army).
- Production of ultra fine grained gear steels for application in next generation rotorcraft power train systems (Army).
- Development of lower-cost molding methods for titanium and superalloy castings with improved quality, dimensional tolerances, surface finish, and production cost (DLA, NASA).
- Development and application of friction stir processing technologies to enhance damage tolerance in cast superalloy rocket propulsion components (NASA).
- Demonstration of tool-less manufacturing technology not limited by conventional injection molding process constraints to produce geometrically complex powder metal and cast parts (NASA).
- Development and production of high temperature shape memory alloys and bulk-sized shape memory alloy structures with highly-controlled shape memory behavior (NASA).
- Fabrication and evaluation of refractory alloy intermetallic composites for use in nuclear reactors under irradiated conditions (DOE).
- Demonstration of transformation superplastic (TSP) forming in coarse grained, cast microstructures (NSF).
EXAMPLES OF APPLICATION AREAS

Aerospace and Defense
  » Higher performance and/or specific strength materials and structures for weight reduction of aircraft, spacecraft, land vehicles, and marine vessels.
  » Lower cost net shape fabrication methods to allow for more affordable titanium parts while maintaining the performance benefits over aluminum and steel.
  » Higher temperature and performance, yet more formable and producible, superalloys for static and dynamic structural components in aircraft engines and rocket propulsion systems.
  » Advanced intermetallic and composite materials for hot section structures in next generation gas turbines and airframes.
  » Reactive materials structures/energetics that replace inert case materials leading to more lethal munitions.
  » Metal physics-based and probabilistic lifing methodologies for more accurate part and structure life management.

Industrial and Consumer
  » Lower cost titanium alloys and near-net shape fabrication methods to allow for their expanded use in cost sensitive applications (e.g., petrochemical pumps and valve components) that will benefit from a superior life cycle cost and performance compared with steel and aluminum.
  » Higher temperature and corrosion resistant superalloys for structural and gas path components used in industrial gas turbines and nuclear reactor systems that are more formable and less expensive.
  » New titanium and shape memory alloys that can be affordably fabricated into bulk size biomedical implants.
  » High performance sporting goods including state-of-the-art golf clubs with enhanced springback effect and custom weighing (tool-less).

CURRENT AND PAST CUSTOMERS

U.S. Government Customers
  » Navy: ONR, NAVAIR, NAVSEA (IWS, NSWC, NUWC), Marine Corps
  » Army: ARL, AATD, ARDEC
  » Department of Energy: Nuclear, ORNL
  » National Science Foundation
  » NASA: Glenn Research Center, Marshall Space Flight Center, Johnson Space Center
  » Missile Defense Agency
  » Defense Logistics Agency

Commercial Customers
  » The Boeing Company (Commercial, Rotorcraft, Phantom Works)
  » General Dynamics (Land Systems, Robotic Systems, Electric Boat)
  » General Electric Company (Aviation, Energy, Global Research Center)
  » United Technologies (Rocketdyne, Sikorsky, Pratt & Whitney)
  » Northrop Grumman (Air Combat Systems, Newport News Shipbuilding)
  » Bell Helicopter Textron
  » Rolls-Royce
  » BAE Systems
  » Raytheon Missle Systems
  » Triton Systems, Inc.
PRODUCTS/SERVICES

For a given project a streamlined activity-based integrated product team (IPT) is usually established with appropriate representation from the sponsor (e.g., government) and end user (e.g., the original equipment manufacturer, or OEM) to identify product requirements and technical challenges. In this manner, an objective analysis will be possible without favoring one material or technology over any other. The IPT team can then formulate a program to develop and/or apply technologies that will maximize cost savings.

T45 strongly embraces the concept of “concurrent engineering” as a means of providing every customer with products that meet or exceed their own unique set of requirements while remaining affordable. Even before the Request For Quote stage, our experienced Engineering, Manufacturing, and Quality professionals work with their counterparts at your business to design process and quality assurance program that “fits the bill” with a high level of repeated efficiency. The size of our business and management structure ensures our customers of detailed and immediate attention to their needs.

CORE ADVANTAGES

Planning for cost effectiveness is one of the most crucial yet underappreciated drivers of “high tech” engineering and manufacturing. At T45, our team of experienced engineers and scientists apply Metallurgy and Materials Science and Engineering to understand materials characteristics and practical manufacturing, quality assurance, and production know-how to affordably produce components with the optimum performance characteristics. For example, exact microstructural control is one of many advantages of the hot die isothermal forging process. Using the latest manufacturing and characterization methods, a number that were developed in-house, our metallurgists and technicians constantly work to monitor and control the production process to ensure its robustness. Just keeping pace with technology is also not enough as T45 continually strives to be at the forefront in developing potentially game-changing technologies. As a result, research and development is and will always be an integral part of our business.

Experienced Staff

The technical staff at T45 has over 200 combined individual years of experience working with advanced materials and manufacturing technologies. Most staff members also have hands-on production level experience from previous positions at primary metal suppliers, casting foundries, forge shops, and/or OEMs. For example, for investment castings, our engineers have been involved with the production of as many as 30,000 aerospace/industrial components per year, and as many as 50,000 consumer product parts per month. The former typically required ISO9002/AS9000 certification as well as accreditation through the National Aerospace and Defense Contractors Accreditation Program (NADCAP). T45 engineers have also achieved NAVSEA qualification for the inspection of production and repair welds in naval titanium pump and valve components, as well as supplier approval for the production of castings and forgings from many of the world’s leading aerospace OEMs including Boeing Commercial Airplane Company, GE Aviation, Rolls-Royce, Pratt & Whitney, Honeywell Engines, Lockheed Martin, Northrop Grumman, Vought, Sikorsky, Goodrich, AeroJet, and Hamilton Sundstrand. The T45 team has the necessary technical and production experience to successfully commercialize new technologies.

The senior technical staff members are known throughout the technical community for their expertise. The core technical team and consultants currently consists of 5 Ph.D.’s, including Fellows of ASM International and ASME and a GE-trained Six Sigma Master Black Belt, as well as 4 Materials/Manufacturing Engineers with 10 to over 35 years of individual experience each. Collectively, the team has over 100 publications and 20 patents.

In-House Manufacturing and Production/R&D Facilities

T45 has on-site facilities and manufacturing equipment ideal for developmental work and low to high volume production. Through local partners and universities, the company also performs advanced characterization, mechanical testing, and computational simulation. All of these capabilities provide the tools necessary for verifying designs, processes, and models against actual fabricated parts, helping to reduce risk and accelerate the technical readiness level of a technology for eventual implementation with the end user.

VACUUM MELTING / CASTING

T45 has consumable electrode vacuum arc melting furnaces for melting and casting high temperature reactive metals including titanium alloys using diverse mold materials. The company maintains a complete line of investment and sand mold making equip-
ment, including wax injection machines, slurry tanks, millers, and kilns/ovens, as well as cutting, grinding, welding (MIG/vacuum TIG), finishing, and machining equipment. Process steps such as hot isostatic pressing (HIP) and nondestructive inspection are done at local vendors.

FORGING PRESSES
Multiple hydraulic presses of up to 500 tons are available for forging, punching/stamping, compaction, and severe plastic deformation for low to high volume production. The company possesses all supporting equipment such as high frequency induction heaters and furnaces to conduct isothermal hot die isothermal forging.

POWER METAL PROCESSING
Vacuum glove boxes, chambers, and powder blenders are available for master alloying and mixing. The powders can then be degassed, pressed, melted, sintered, and/or HIPed as required in-house or at outside vendors.

MATERIALS CHARACTERIZATION
Standard characterization work including metallography and optical microscopy is performed in-house. Scanning electron microscopy (SEM), SEM-based analysis, and mechanical testing are conducted at local vendors or with partners. For example, advanced characterization work such as transmission electron microscopy (TEM) and nano-indentation testing are available at the Thermal Processing Technology Center at the Illinois Institute of Technology for which T45 is an Affiliate Member.

COMPUTATIONAL SIMULATION AND FINITE ELEMENT ANALYSIS
T45 possesses in-house computational capability to develop and conduct the simulation of manufacturing processes and materials behavior. Through strategic small business partners and universities, the company can offer finite element analysis using commercial off-the-shelf software such as DEFORM, FORGE, and ANSYS.

Security Clearance
T45 possesses Secret level security clearance with the U.S. Government. The company also establishes mutual Non-Disclosure Agreements with its customers, suppliers, and partners, enabling its technical staff to work closely with customers without compromising confidentiality. In addition, T45 maintains a Military Critical Technical Data Agreement (DD Form 2345) so that qualified employees may view ITAR-controlled information.
THE COMPANY

Background
Founded in 2005, T45’s primary strengths lie with its highly experienced technical staff, vibrant research collaborations, and in-house manufacturing capabilities for near-net shape components. More recent technologies that the company has been actively developing include not only other bulk processing methods such as rapid prototyping and tool-less manufacturing, but also surface modification techniques (i.e., friction stir processing), spray forming (e.g., cold spray), and accelerated insertion of materials. When successfully developed, many of these technologies will also be patented. While a small company is typically limited in available manpower and resources, T45 is unique in that it can leverage its technical strengths across multiple areas through effective cross-linking both internally and with consultants and partners in the industry, academia, and Federal Government. The highly interdisciplinary approach T45 consistently takes allows it to creatively target new technologies of future relevance while retaining its core strengths.

Technical Team
Edward Y. Chen: Dr. Chen is the founder of T45 and currently serves as its President. He has over 15 years of experience in the field and has been the program manager and/or principal investigator for over 20 government and/or industry sponsored projects on advanced materials and manufacturing technologies. In a previous position and employer, he successfully led the company to its first ever ISO9002 and AS9000 certifications and NADCAP re-accreditation for Heat Treat, Etch, Welding, and Nondestructive Testing. He was also trained in Six Sigma and DFSS while a Staff Materials Scientist with GE Global Research (Niskayuna, NY). Dr. Chen received his M.S. and Ph.D. degrees in Materials Science and Engineering from Northwestern University, and his B.S. Mechanical Engineering degree from the University of Southern California. He is a recipient of the Engineering Against Fatigue Competition Prize and Engineering Foundation Fellowship.

Charlie C. Chen: Dr. Chen has 40 years of experience in the processing of titanium and aluminum alloys, Ni-based alloys, steels, and advanced materials. He has served in a program manager, project engineer, and/or consultant for many U.S. Government and industrial contracts in collaboration with Boeing, GE, Lockheed Martin, the Air Force, and many other major U.S. aerospace primes. He has made significant materials technology contributions for the development of airframe, aircraft engine, and missile structural components, most notably in the area of isothermal hot die forging technology. Dr. Chen is the founder of 3 high technology businesses focused on advanced manufacturing and metalworking technologies. He is a Fellow for the ASM International and was honored with an Honorary Doctorate Degree in Engineering (2002) by the Michigan Technological University, where he received his M.S. and Ph.D. degrees in Metallurgical Engineering.

Douglas R. Bice: Mr. Bice has over 35 years of experience in manufacturing with over 25 years of that spent in titanium and reactive metal foundries. He is a technical expert on the design, engineering, and production of titanium and reactive metal castings through the lost-wax investment, rammed graphite, and semi-permanent molding methods, and has actively worked on advanced manufacturing projects on superalloys, intermetallic alloys, composite materials, and powder metals.

Erin M. Perry: Ms. Perry is a computational materials scientist with 20 years of experience in process modeling and developing software for tooling and process design of diverse manufacturing processes to predict the formation and performance of parts. She has a B.S. degree in Materials Science and Engineering from Cornell University; an M.S. from Northwestern University in the same field, and a M.S. degree in Computer Science from Union College.