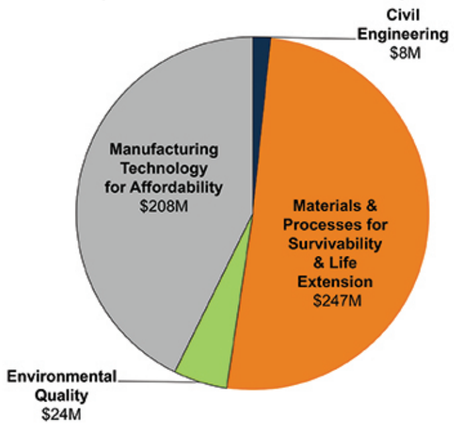
Materials and Manufacturing Processes

Materials and Manufacturing Processes: The purpose of the Materials and Manufacturing Processes COI is to provide National leadership in developing technology-based options for advanced materials and processes for the Department of Defense. The COI delivers technology products as well as the scientific and engineering expertise needed to maintain and enhance U.S. Defense capability.

The COI achieves these objectives through direct integration and coordination of eight (8) key technology activities and by continuing collaboration with the best expertise available in related activities across the broader materials and manufacturing fields, whether domestic or international. The cross-DoD technology teams currently making up the COI include SMEs in the materials and manufacturing processes for the following: Structures and Protection; Propulsion and Extreme Environments; Sensors, Electronics, and Photonics; Power and Energy; Readiness; Individual Warfighter; Civil Engineering; and Corrosion.

Defense Technology Binnings for FY 2015
(Total Investment at $487M)



Steering Group
Dr. Jeffrey Zabinski (Army)
Dr. Julie Christodoulou, Chair (Navy)
Dr. Daniel Miracle (Air Force)
Mr. Ellison Urban II (DARPA)
Dr. Steven Wax (DTRA)
Dr. Lewis Sloter (ASD/R&E)

Tier 1 Thrust Areas

Materials/Processes for Survivability & Life Extension
Materials/Processes for Survivability & Life Extension is comprised of all materials and processes that enable mission operations. This contains M&MP COI technical area teams for structures and protection; propulsion and extreme environments; sensors, electronics and photonics; power and energy; the individual warfighter; corrosion; and readiness.

Civil Engineering
Civil Engineering supports all aspects of technology necessary for force protection, force projection, and sustainment, including logistics planning, amphibious assault and rapid port enhancement, base and in-theater infrastructure, and force protection on the battlefield and at installations and bases with an emphasis on expedient protection systems. Projects are reported in the M&MP technical area team, Materials and Processes for Civil Engineering.

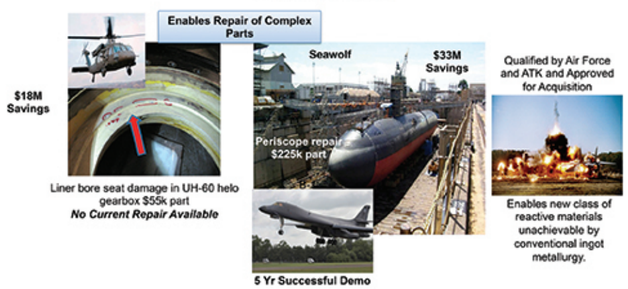
Manufacturing Technology for Affordability
Manufacturing Technology for Affordability contains the materials, processing and fabrication techniques to significantly change the manufacturing cost curve. This includes but is not limited to processing and fabrication of electronics, composites and metals, as well as emerging capabilities developed within the advanced manufacturing enterprise. This is coordinated via the Joint Defense Manufacturing Technology Panel (JDMTP) and efforts are integrated into M&MP technical area teams' roadmaps for Materials/Processes for Survivability & Life Extension.

Environmental Quality
Environmental Quality reflects the DoD activities conducted within the framework of the DoD-DoE-EPA Strategic Environmental Research and Development Program (SERDP). This includes research and development in five program areas: energy and water; environmental restoration; munitions response; resource conservation and climate change; and weapons systems and platforms.

Recent S&T Accomplishments and Transitions

Cold Spray Delivers Build and Repair Capability - 7 yrs

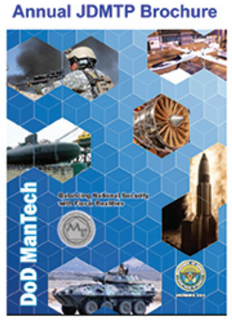
Tech Breakthrough: Materials by Design & on Demand
- Multi-scale materials research yielded exceptional feedstock for CS process
- Processing Science produced exceptional repair properties
- Manufacturing Science produced automated equipment
- ~$100M annual DoD Savings



Liner bore seat damage in UH-60 helo gearbox $55k part
No Current Repair Available

5 Yr Successful Demo

Annual JDMTP Brochure



https://www.dodmantech.com/JDMTP/AnnualJDMTPBrochure

High Energy Density Capacitors for Pulsed Power

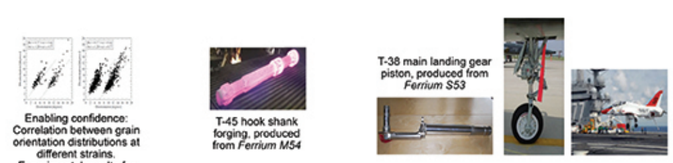
Tech Breakthrough: Army ManTech Investments, 2004-2008 (ARL)
- First ¼ MJ safe mS capacitor was built and tested with 2.4 J/cc: Rail Gun
- First long DC life 12.5 kJ µS discharge capacitor with 1.3 J/cc: EM Armor
- Improved electrode design/manufacturing, impregnation, assembly

Innovative Dielectric Materials: Key to Future Higher Energy Density Pulsed Power Capacitors, 2006-Now (AFRL/ARL/ONR)
- Materials research yielded new dielectric films and new components
- Film processing yielded improved breakdown strength
- Coupled with capacitor manufacturing technology for improved capacitors

Navy Rail Gun | Army EM Armor | Air Force High Power Microware

- **ManTech pushed SOA materials to new levels of performance**
- **New Materials systems are needed for further improvements**

Realizing ICME from Discovery to Manufacturing: Building an integrated, quantified knowledge base across length scales and technology maturation levels



Enabling confidence: Correlation between grain orientation distributions at different strains. Experimental results for aluminum (left) and analytical (right).

T-45 hook shank forging, produced from *Ferrium M54*

Aerospace-grade steel alloys and processing designed and certified using ICME in < 7 years

Both the component geometry and the material can be optimized simultaneously and synergistically with knowledge of performance requirements, model and data uncertainty, and quantitative reliability indices to enable rapid qualification of the materials and processes. ICME is being used to quantify our understanding and articulate that knowledge base in tools for manufacturing protocols to optimize performance and affordability and predict service lifetimes.

Gaps and Engagement Opportunities

Technical Area Team 1 – Structures & Protection

- Material Models
- Material Failure/Fracture Modeling
- Joining Dissimilar Materials
- Availability of Strategic Raw Materials
- Agile Laser Protection

- ICME
- Rapid Material Qualification
- Integrate Advanced Materials to Enhance System Performance
- Demonstrate Improved Platform Performance

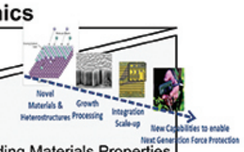
Technical Area Team 2 – Propulsion & Extreme Environments

- CMC and Additive Manufacturing Certification/Acceptance
- Thermal Management & Sensor Materials at Extreme Temps
- High Temp Turbine Engine Materials >1500°C
- Materials Screening Testbed for Hypersonic Aerosurfaces

- ICME
- Rapid Material Qualification
- Integrate Advanced Materials to Enhance System Performance
- Demonstrate Improved Platform Performance

Technical Area Team 3 – Sensors, Electronics, & Photonics

- Limited Processing Methods for Nano & Integrated Photonics Materials
- Lack of Affordable Large Area CMOS Compatible Substrates
- Lack of Physics Based Predictive Models
- Inability to Scale-Up 2D electronics
- Lack of New IR Materials



- Understanding Materials Properties
- Develop Scale-Up Methodologies for MF and EM Electronic Materials
- Develop Novel Electrodes & Investigate the Film/Electrode Interface
- Advanced Processing Methods to Enable Low Temp Growth and Integration

Technical Area Team 4 – Power & Energy

- Computational Tools for Modeling Multi-Material & Multi-Scale Electromechanical Processes
- Limited Life, Organic Electrolytes, and New Materials for High Energy Density Batteries
- Limited Knowledge and Control Over Nanoparticle Dispersion
- Lack of Sulfur-Resistant materials for Fuel Cells
- Inadequate Ink Development

- Scalable Low-Cost Processes
- Accelerate Materials Development
- Develop Characterization Techniques
- Develop Nano-Structured Device Architectures; Multi-Functional Materials

Technical Area Team 5 – Readiness

- Tools to Reduce Conservatism Through Assessment and Modeling of Microstructural Features and Variability
- Damage Assessment of Advanced Materials
- Variations in Manufacturing Processes
- Inspection Techniques and Detection

- ICME
- Maximize Use of NDI Models & Data
- Model-Guided Inversion of NDE Data
- Characterizing Degradation of Materials Coatings
- Damage Detection & Assessment, Prediction, Lifing, Sustainment

Technical Area Team 6 – Warfighter

- Integrated Armor Performance and Warfighter Injury Protection
- Materials and Systems that Provide Reactive Decontamination and Super Omniphobicity
- Low Thermal Burden Chem/Bio Protection

- Tech Demos
- Models to Facilitate Ensemble Design
- Novel Test Methods to Characterize Performance
- Development of Layered Reactive Decontaminating Materials for Chem/Bio IP

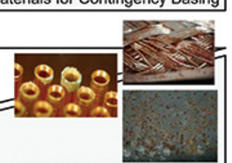
Technical Area Team 7 – Civil Engineering

- Operational Maneuverability Through Lighter Weight Surfacing in Austere Environments
- Sustainable Bases in all Operational Environments Using Indigenous Materials
- Lighter, Easily Constructed Force Protection

- Material Modeling
- Austere Airport of Debarkation and Seaport of Debarkation Entry Establishment
- Installations – Indigenous Construction Materials for Contingency Basing

Technical Area Team 8 – Corrosion

- Corrosion Informed Materials Selection and Design
- Tools to Predict Materials Performance and Time-To-Failure
- Corrosion Design Trade Tools to Evaluate Risk and Estimate Cost



- High Performance Coatings
- Multi-Scale Corrosion Damage Models
- Structural Component Simulation
- Corrosion Sensors and Repair Tools