SERDP/ESTCP Metal Finishing Workshop

General Session
May 22, 2006

Workshop Goals:

- **What is state of the art?**
- **What are the technology gaps?**
- **What needs to be done to meet regulatory pressures?**
- **What are the barriers to implementation?**
- **Determine research agenda.**
- **Community input on priorities.**
- **Focus on chromium, cadmium, and pre-treatment with hexavalent chromium.**
- **Free-form discussion of next steps.**

Accelerating Technical Transformation: Bridging the Valley of Death for Materials and Processes in Defense Systems *By: Carol Handwerker*

<u>Summary Points</u>

Common characteristics of three studies where technology was transferred successfully
- Multidisciplinary teams lead by champions
- Ability to communicate awareness of problems
- Take risks at the enterprise level

Fundamental Implications
- Feel empowered to take risks
- Plan for future
- Teamwork and collaboration
- Allowed to experiment
- Failure provides lessons

Do you have this culture?

Methodologies and Approaches – 3 corporate best practices
- Developing a "viral" process for technology development
- Increase reliance on functional requirements rather than specifications
- Developing a mechanism for creating successful teams as new systems are envisioned.

<u>Summary of Key Questions/Responses</u>
- How to develop a culture so that the armed forces in general, not individuals, reap benefits, especially when top leaders are employed in rotation?

Ensure that the person making decision has all the data necessary to make decisions about tradeoffs. There is a natural tendency to stay in a comfort zone and decrease uncertainty. Make sure there is concrete data and an evident return on investment.

- There are also risks associated with not taking action. Often, cost savings can get taken out of the future budget, thereby hindering further developments.

- Can lessons be learned from post-World War II? Especially with regard to fast turnaround?

  There was a higher willingness to take risk. Also, the military structure in place today did not exist.

- There is a disconnect between theory and practice in real materials engineering. Ways to address this include sustained funding, specifying targets where the technology will be used, holding annual meetings for information exchange, and shortening iteration cycles. Need to minimize barriers between research groups (i.e., academia, with different research objectives may develop technology that the services cannot use for a specific application).

- There is already a lot of attention on risks, so perhaps a focus on long-term rewards could be useful. Encouraging rewards could encourage risk-taking.

- How to replicate instances of rapid technology transfer? Work with universities to develop targeted research; get end-users comfortable with developers of technology.

Environmental Issues and Corrosion *By: Lew Sloter*

Summary Points

- Integrated Product Team Structure
- Downloadable Report to Congress (Nov. 2003) – www.dodcorrosionexchange.org
- Environmental Issues – DoD policy to:
  - Protect DoD personnel from accidental death, injury, or occupational illness
  - Protect public from risk of death, injury, or property damage because of DoD related activities.
- Pollution prevention is the policy of DoD
- Material selection and processing, corrosion prevention research, and engineering, and implementation have a crucial role to play in meeting DoD policy and goals.
- Ultimate solution involves working together.
- Strategy for corrosion prevention and mitigation:
  - Maturation of technology

    - Minimize risk
    - Increase reward
- Culture of technology development: move away from “greener” substitutions that perform equally toward those that perform better.
- Advances in metal finishing will be an important part of corrosion control.
- Resolve discrepancy between product specifications and desired performance.

Summary of Key Questions/Responses

N/A

Current and Upcoming Regulations *By: Christian Richter*

Summary Points

- Backdrop on Metal Finishing Regulatory Trends
    - New framework is international and dynamic
    - US leader in environmental policy (1970 – 1995)
    - EU leader in environmental policy (1995 – present)
- Three classes of metals
    - Cr, Pb, Cd
    - Ni
    - Co, Zn, other metals, nanotech
- Greater emphasis of societal implications of pollution issues
- EU – precautionary response, errs on the side of regulation
- US – science first, then regulations
- California as example of tighter regulations, new challenges
- Technology-based vs. materials-based controls

Summary of Key Questions/Responses

- Metals under scrutiny can be seen as challenges and opportunities. Solutions quickly turn into their own problems.

- The electronics industry was surprised by the legislation against lead-tin solder. How can data-driven decision-making be discussed with the government? More active participation from the industry is needed.

- With regard to regulations, offshore activities can worsen issues globally. EU approach – only can sell products in EU markets if they conform to EU standards.

- Composites have their own issues and are an important topic for discussion.

- With regard to lead-free solder, what about older equipment? Compatibility issues are being addressed now. There is a military effort to assess sites.

- What about high-risk nickel processes? EPA's risk assessment will help to sort out impacted processes. There will be a focus on nickel-soluble materials.

Clean Alternatives *By: Keith Legg*

Summary Points

- Hard-chrome alternatives: Alumi-Plate for enclosed systems
- Closed thermal sprays, non-aqueous processes: Vaccuum Coatings
- Welding: microworking (very small processes)

Summary of Key Questions/Responses

N/A

Tactical Vehicles *By: John Beatty, Tom Sachar*

Summary Points

- Difficult uses to change
    - CCC on Al electronics casings/housing
    - Cr^{6+} rinses

- Next targeted changes
    - Pre-treatments

- RDT&E challenges
    - Aluminum based coatings – corrosion
    - Stricter pre-treatment process control required for acceptable corrosion control tolerance.

Summary of Key Questions/Responses

- For general fasteners on EFVs, coatings were eliminated and stainless steel used instead.

- Fasteners will encounter the same problems repeatedly until the government changes specifications across the board (e.g., different coatings).

Aerospace and Missiles *By: Eric Brooman, Sheldon Toepke*

Summary Points

- Environmentally acceptable alternatives for cadmium and chromium coating

    - Focus on *health* as well as environmental effects and include these (health) costs when deeming a process "environmentally acceptable."
- OSHA recommends seeking alternative technologies in its guidelines; protective clothing as a last resort. In practice, facilities' first response is protective clothing.
- Guidance for selecting alternative technologies
    - Must perform better or equal to current technology
    - Environmentally acceptable
    - Production friendly (workload maintained)
    - Cost effective
    - Minimum facility change requirements
    - Worker friendly
    - Repairable
    - Maintainable
- Technical/Performance Requirement Issues
    - Short Term (< 3 yr) - HVOF thermal sprayed WC-Co and plasma sprayed Tribaloy™ only approved alternatives for chromium; and IVD aluminum only approved alternative for cadmium
    - Mid term (3-5 yr) - electroplated nano-Co-P and electroless Ni-P+SiC may be robust enough for replacing chromium; electroplated aluminum may be robust enough to replace cadmium for small parts; PVD metals (e.g., Al), alloys or compounds may be suitable to replace cadmium and/or chromium for some applications where flight safety not an issue (until the processes/coatings can be qualified)
    - Long Term (5-10 yr) - best candidates probably will contain nickel and/or cobalt; however, these may become more regulated and their use more restricted: worker exposure will be reduced by using CVD and/or PVD processes and materials substitution may eliminate the need for coatings in some applications.
- Lessons Learned
    - Very few materials eliminated due to environmental and/or occupational and health pressures alone.
    - Customers specific requirements and the improved performance of alternative technologies greatly reduce implementation of "bad" processes and materials.
    - There is a lack of confidence in ESH cost projections.
    - Few (financial) incentives for companies to develop and qualify alternative processes and coatings for the DoD; the markets are too small unless the technology is "dual use".

<u>Summary of Key Questions/Responses</u>

N/A

Gun Barrels *By: Mike Audino*

Summary Points

- Guns and Barrels – one of the single largest users of chromium plating
- Reseal procedures use a lot of chromium
- Autofrettage – makes a much lighters gun barrel for the loading that it can carry
  - Alternatives constrained by temperature (deposition temperature)
  - Tantalum and its alloys as an option.
- Sputtering: cleaning the most important challenge
- Chromium-plating failures: produced "as cracked," allow paths to substrate that allow for more cracking during off-gassing
- New hexavalent chromium PEL – no effect
- Testing Process:
  - Cylindrical Coupons → process steps
  - Full-diamater
  - Full size barrel
- Verification techniques

Summary of Key Questions/Responses

- The experimental process of sputtering is limited to one tube per bay. Unless it is a time of war, there is also a limit of four tubes at a time, because of the Clean Air Act.

- Sputtering causes an increase of price because of the time involved for the process.

- Goal: 400 high energy rounds or 1500 low energy rounds.

Joint Strike Fighter (F-35) *By: Scott Fetter*

Summary Points

- Material Disposal – should be part of life cycle, currently goes in landfill.
- Operate under hazmat management plan.
- System changes/Improvements
  - Cadmium fasteners→Aluminum/titanium structure aircraft using titanium/steel fasteners: changing to nickel relatively easy, cost-wise. Now only have cadmium in gun, the engine mounting rig, and small bolts in the cockpit.
- Working on continuing qualification of non-chrome structural primer after baseline approval.
- Major issue is altering existing contracts to move sub-contractors and vendors toward using alternatives.
- Test procedure:
  - Salt fog testing
  - Field exposures at beach

        - Indian Ocean cruising
- C-130 hatches:
    - Investigating other primers
    - Cd.-plating connectors a challenge (Cd-Ni plating)
    - Need for greater corrosion resistance.
- Copper-beryllium bushing replacement: innovations in inspecting corrosion on the inside of a functioning aircraft
- Gap-fillers: Northrop Grumman working on developing filler material, but qualifying it very expensive.

Summary of Key Questions/Responses

- Nitrionic bushings are unlubricated and unlined.

- A non-chrome primer is used in JSF. Vendors were asked for chromium alternatives and only one survived.

UAVs and UCAVs *By: Stephen Gaydos, Joseph Osborne*

Summary Points

- UAV – Unmanned Air Vehicles (used for surveillance missions)
    - Majority of efforts spent on meeting UAV performance requirements
    - "Green" UAV – customer has to be willing to invest; nothing in regulations regarding cadmium/chromium
    - Potential of composite structure (787 is largest use of composite)
    - Concern about ID/OD

- UCAV – Unmanned Combat Air Vehicles (used for strategic bombing)

- Need shift in procurement to go green
    - No alternatives to nickel exist (cobalt is more dangerous and will soon be more regulated by EPA/OSHA)

Summary of Key Questions/Responses

N/A

Future Combat System and Stryker *By: John Beatty, Geoff Hoerauf*

Summary Points

- Alternative materials available, but do not satisfy military requirements
- New specs: 17 materials now prohibited as well as low-level radioactive waste
- Tracking system on materials usage
- Joint Group on Pollution Prevention

- Need list on useful treatments, not just a list of prohibited ones

Summary of Key Questions/Responses

- Validation: some parts are not as critical for automobiles as they are for military vehicles. Who should perform validation? There is also an issue of spare parts supply.