Requirements Summary

• Interested in all environments
• Monitoring requirements depend on investigation and orbit
• Environmental factors:
  – Spectral radiation data:
    • Solar wind
    • Plasma
    • Low energy electrons and protons
    • High energy electrons and protons
    • Ultraviolet (UV)
    • Vacuum UV (VUV)
    • Soft X-rays
    – Atomic oxygen
• All missions benefit from better materials information
  – NASA, commercial, military, other government
Materials Technology Breakout Session

Materials Technology Breakout: Prioritized List

1. Ground-to-Space Correlation for Materials Degradation
2. Slow Crack Growth in Polymeric Films
3. Embrittlement of Polymers (Surface/Bulk)
4. Molecular Contamination
5. Variable Optical Property Materials
7. Atomic Oxygen/UV Radiation Synergistic Effects
8. Role of Oxygen Ions in On-Orbit Erosion (Atomic oxygen versus O+)
9. Long-Term Charging Effects on Materials
10. Composite Materials

SET-2 Requirements Workshop, Sept. 11-12, 2003
Technology #1: Ground-to-Space Correlation for Materials Degradation

• Justification for Requirement:
  – Ground tests often do not simulate the degradation that occurs in materials in the space environment
  – Need flight data to correlate to ground test data

• Correlative environment measurement requirements:
  – Spectral radiation data:
    • Low energy electrons and protons
    • High energy electrons and protons
    • Solar wind
    • Plasma
    • Ultraviolet, vacuum ultraviolet, soft X-rays
  – Atomic oxygen

• Environments of Interest: All environments
Technology #2: Slow Crack Growth in Polymeric Films

• **Issues:** The effects of the following on slow crack growth in polymeric films need to be quantified:
  – Threshold dose or load
  – Dose rate effects
  – Temperature effects (dwell and soak)
  – Load effects

• **Possible experiment techniques:**
  – Micro-Electro-Mechanical Systems (MEMS) for monitoring of materials’ properties
  – Photodetectors

• **Correlative environment measurement requirements:**
  – Monitoring is experiment/environment dependent
  – Spectral radiation data: low energy electron and proton, high energy electron and proton, solar wind, plasma, UV, VUV, soft X-rays
  – Atomic oxygen

• **Environments of interest:** All environments
Technology #3: Embrittlement of Polymers (Surface/Bulk)

• Contributions of the following effects to the embrittlement of polymers needs to be quantified:
  – Ultraviolet (UV), vacuum UV (VUV), electrons and protons, other radiation?
  – Synergistic effect with atomic oxygen (AO): flux rate effects
  – Radiation dose rate effects
  – Temperature effects
  – Load effects

• Correlative environment measurement requirements:
  – Depends upon experiment/environment
  – Spectral radiation data: low energy electron and proton, high energy electron and proton, solar wind, plasma, UV, VUV, soft X-rays
  – AO

• Environments of Interest: All environments
Technology #4: Molecular Contamination

- **Issues/possible experiment investigation requirements:**
  - Electrostatic Return
  - Photopolymerization/ fixing
  - AO scrubbing (removal) versus fixing
  - Temperature effects
  - Contamination source identification techniques
  - Effects of voltage bias on contamination rates and species

- **Correlative environment measurement requirements:**
  - Ultraviolet (UV), vacuum UV (VUV), atomic oxygen, pressure

- **Environments of interest:** All environments
  - Dose in <10 eV range
Technology #5: Variable Optical Property Materials

• **Issue:** Interactions with space environment (verify performance in space environment) for:
  – Thermochromics
  – Electrochromics
  – Photochromics
  – Micro-Electro-Mechanical louvers

• **Correlative environment measurement requirements:**
  – Obscuration due to contamination
  – Atomic oxygen
  – Ultraviolet/vacuum ultraviolet
  – Total dose

• **Environments of interest:** All environments
Technology #6: Performance Characterization of Coatings and Films in Space

• **Issue:** Need for flight qualification of coatings and films such as:
  – Atomic oxygen (AO)-durable materials (i.e., POSS)
    • Flexible AO protective coatings
    • Paintable/spray-on AO durable coatings
    • Conductive AO durable coating (ITO replacement)
  – Metal durability (vapor deposited coatings)
  – Conductive coatings
• **Correlative environment measurement requirements:**
  – Depends upon the investigation
• **Environments of interest:** LEO/GEO environments
Technology #7: Atomic Oxygen (AO)/Ultraviolet (UV) Radiation Synergistic Effects

• Issue: What are the variations in the synergistic effects of AO and UV on materials due to:
  – Solar cycle variations
  – Dose rate effects
  – AO “scrubbing” off (removal of) UV embrittlement
  – Temperature effects

• Correlative environment measurement requirements:
  – AO
  – Spectral UV and vacuum UV
  – Total dose

• Environments of interest: LEO environment
Technology #8: Role of Oxygen Ions in On-Orbit Erosion: Atomic Oxygen (AO) Versus Positively Charged Oxygen (O+)

• **Issue:** Characterize the role of oxygen ions in on-orbit materials’ erosion including:
  – Low erosion yield materials
  – Potential solar cycle variations
  – Flux rate effects
  – Temperature effects

• **Correlative environment measurement requirements:**
  – AO and O+
  – Spectral ultraviolet (UV) and vacuum UV
  – Total dose

• **Environments of interest:** LEO environment
Technology #9: Long-Term Charging Effects on Materials

• Issue: What are the long-term charging effects on materials including:
  – Thin Film Materials Effects: mechanical and optical properties
  – Flux Rate Effects on Property Changes
• Correlative environment measurement requirements are experiment/environment dependent:
  – Spectral radiation data (low energy electron and proton, high energy electron and proton, solar wind, plasma, UV, VUV, soft X-rays) AO
• Environments of interest: All environments
Technology #10: Composite Materials

• **Issue:** Performance characterization of composite materials:
  – Strength/Stiffness on-orbit
    • Synergistic effects with radiation/thermal cycling or thermal dwell
  – Radiation Shielding Integrated Composites
    • Importance increases with miniaturization and need for ultra lightweight

• **Correlative environment measurement requirements:**
  – Atomic oxygen
  – Total dose

• **Environments of interest:** All environments