Titanium
Protecting the Soldiers of Operation Iraqi Freedom

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Background

• The evolution of operations in theatre from force-on-force battle to counterinsurgency has required a significant shift in Army force protection
• Light tactical vehicles such as HUMMWV’s and Medium trucks have traditionally had minimal ballistic protection
• Tactical vehicles such as armored personnel carriers and tanks have excellent ballistic protection, but have poor visibility when the crew rides “buttoned-up”
• As a result, there are a number of applications where add-on armor is required to the basic army combat vehicle, either to provide baseline ballistic protection (light vehicles) or protection to soldiers who are exposed in open commander hatches, cupolas, and gunner platforms
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Light tactical vehicles
Canvas Doors

Tactical vehicles
Exposed Crew Members
The solution: Add-on armor packages

The problem: Weight

• Most Army efforts in add-on armor have focused on steel solutions
• Steel weighs about 15 lbs/ft3 for current theatre threat
• Armor packages in steel are so heavy that they affect vehicle/system performance
Titanium is an excellent alternative to steel:

- 30% lighter for an equivalent ballistic protection
- Less expensive than composites
- Isotropic and easy to work with compared to specialized materials
- However, titanium availability and price have traditionally impacted use of titanium in Army applications

These are not traditional times……. the Army is now fielding titanium ballistic solutions in cases where weight really matters.
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Stryker FSV/RV Vehicle Commander Lightweight Protection-Design Guidelines

- Maximize **protection** level and coverage
- Minimize **weight** - target of 100 to 120 lbs
- Maintain **situational awareness**
- Utilize proven ballistic **materials**
- Utilize common **manufacturing** processes
- Even **distribution** of weight
- Minimize number of **components**
- Utilize existing **attachment** points
- Ease of **assembly**
- Provide **structural integrity**
- No **interference** with weapon and FS3
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Stryker FSV/RV Vehicle Commander Lightweight Protection - Design Guidelines

**Titanium:**
- Ti-6Al-4V
- Areal Density: 11.5 lb/ft²
- Lightweight alternative to RHA Steel
- Fabricated with conventional processing methods
- Good multi-hit ballistic capability
- High strength-to-weight ratio

**Transparent Armor:**
- Bullet Resistant Glass Laminate (glass, polycarbonate, acrylic)
  - Areal Density: 17 lb/ft²
  - Good multi-hit ballistic capability

*Enhanced Survivability for the Soldier*
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Comparison of Concepts

<table>
<thead>
<tr>
<th>Composite Alternative</th>
<th>Titanium Alternative</th>
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<tbody>
<tr>
<td><strong>Material:</strong> Spectra Shield</td>
<td>Ti-6Al-4V</td>
</tr>
<tr>
<td><strong>Number of unique parts:</strong> 6</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total kit mass:</strong> 115 lbs</td>
<td>118 lbs</td>
</tr>
<tr>
<td><strong>Mass of heaviest component:</strong> 58 lbs</td>
<td>58 lbs</td>
</tr>
<tr>
<td><strong>Max height above cupola:</strong> 27 in</td>
<td>24 in</td>
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