PROBLEM TITLE
10,000 psi (6000m) rated composite pressure vessels

PROBLEM TYPE
Circle one (if Other describe below)
Cybersecurity/Energy Resilience/Other: Pressure Vessel

BACKGROUND
A general description of the problem to be solved

- How did this problem come to be? Fleet need for small UUVs to reach full ocean depth.
- Why is it important? Small UUVs are mainly shallow water rated, unchartered domain
- Have there been any other previous efforts to solve this problem? Yes, but not successful
- Why has the problem not been solved yet? Composite material can be inconsistent
- Who is affected by the problem? Subsea community

CHALLENGE STATEMENT
Build a composite (or other hybrid/meta-material) payload section for a small UUV that will survive full-ocean depth pressures (6000m / 10,000psi). It would likely be desirable for the design to be scalable to larger UUV's.

OPERATIONAL CONSTRAINTS

- Must be able to withstand extreme pressure (10,000psi)
- List previously attempted technologies and why they failed:
  - 4.0" Inner Diameter (ID) / 4.875" Outer diameter (OD) Carbon Fiber unit failed pressure testing at 4800 psi (3300m) Moore Bros assumes processing errors
  - Amalga Composites units failed at 6970 psi (4770m), same dimensions
  - Moore Brothers improved unit survived one cycle to 10,000 psi
  - Then the following week a cycle test was performed:
    - The cycle test was 5 minutes per cycle with a 30-minute hold on the 10th cycle. At roughly 4 minutes and 40 seconds into the 4th cycle to depth, the hull let go.
  - Next steps: Increase OD, losing some buoyancy but gaining strength.

PROBLEM SPONSOR AND LOCATION
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PROBLEM TITLE
Self-Healing Methods for Composite Materials

PROBLEM TYPE
Other (Platform Design / Survivability, Advanced Materials)

BACKGROUND
The use of composite materials in the design of weapons, electronics, and vehicles is of significant and growing interest in the US navy, due to high strength-to-weight ratios, long life, reduced signatures, and low maintenance costs. However, composite materials are known to be highly susceptible to damaging cracks or tears deep within the structure that are difficult to detect and sometimes impossible to repair. This causes unique challenges for Navy vessels that are underway, since the risk for damage due to high pressures at deep ocean depths, shock events, and contact with foreign objects is significantly increased. Small cracks and tears due to submergence, surfacing through ice, and thermal cycling can cause a notable decrease in the structural integrity and mechanical strength of the composite material. Self-healing composite materials will benefit the Navy by improving its ability for rapid repair of composite submarine components that experience damage while underway allowing the mission to continue or return safely to port. The desire is to develop a self-healing composite material system that can function in an undersea environment; potentially providing a unique solution to some of the Navy's challenges

CHALLENGE STATEMENT

The Undersea Warfare community needs a self-healing material system for composite structures and/or vehicles in order to mitigate and/or counteract the adverse effects of fatigue, cyclic, and low impact damage while potentially extending service life and reducing maintenance costs.

OPERATIONAL CONSTRAINTS
Used to define a box for team to operate in. Provide bullet comments:
- The method shall not affect the structural integrity of the structure or operational capabilities such as stiffness / strength.
- Shall be suitable for extreme pressures, ocean depths, and sustained long term deployment
- Shall not require continual maintenance

PROBLEM SPONSOR AND LOCATION
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PROBLEM TITLE
Mitigating Adverse Marine Effects on Composite Materials

PROBLEM TYPE
Other (Platform Design / Survivability, Advanced Materials)

BACKGROUND

The navy has a desire to forward deploy advanced payloads in marine environments where there is an inherent exposure to long term seawater submersion along with deep ocean depths. When considering military scenarios there is a further risk of exposure to shock and dynamic loading conditions. Thus there is a need to develop a robust means for coating/encapsulating composite payloads / vehicles to protect them from the degrading effects of seawater absorption over very long submergence times (i.e. forward deployed payloads) under extreme pressures. The encapsulation method also shall provide the opportunity for increased dynamic loading protection through the use of advanced elastomeric materials (i.e. polyurea, polyurethanes, foams). Thus, a combined method which both increases the resistance to the adverse effects of seawater ingression/absorption while also increasing payload survivability is warranted.

CHALLENGE STATEMENT

The Undersea Warfare community needs a robust encapsulation/coating method for composite structures and/or vehicles in order to protect them from the adverse effects of long term seawater immersion/exposure and severe dynamic loading.

OPERATIONAL CONSTRAINTS
Used to define a box for team to operate in. Provide bullet comments:

- The encapsulation method shall not effect operational capabilities such as hydrodynamic or endurance.
- Shall be suitable for extreme pressures, ocean depths, and sustained long term deployment
- Shall not require continual maintenance as forward deployed payloads may not be accessible after deployment

PROBLEM SPONSOR AND LOCATION

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