

Light Weight High Strength Hollow Silicon Carbide Shells for Ultra Deep Sea Vessels

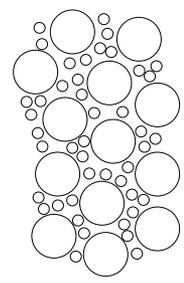
Oliver Strbik – Deep Springs Technology
 Noel Tessier – Engineered Syntactic Systems
 Joe Cochran PhD – Georgia Tech, MSE
 Peter Marshall PhD – Georgia Tech, MSE

Background

Hollow sphere technology is a critical component of syntactic buoyancy foam for deep diving submersibles. Syntactic foam is a composite material combining pre-fabricated hollow spheres in a surrounding matrix.. Syntactic foam provides positive buoyancy to counterbalance the thick hull with associated battery, motor, fairings and other components. The weight and volume of the foam itself is an important consideration. To meet the demand for more efficient syntactic foam the density of the fixed buoyancy material needs to be the same or less than that presently in use while maintaining hydrostatic strength.. A survey of potential vendors showed that this would be nearly impossible without significant technical developments in the area of hollow sphere technology.

Discussion

One way to reduce the density of the syntactic foam and maintain its hydrostatic performance is to improve the packing factor of the microspheres in the resin matrix. The present system has a packing factor in the range of 72-74% by volume. To push the syntactic density to the desired level, the packing factor will need to increase along with density reduction of the microspheres by as much as 15%. A combination of microspheres with different sizes would allow for improved packaging factor.



Methodology

Hollow silicon carbide shells (HSCS) were bi-modal mixed with 3M glass microspheres. The spheres were incorporated into a polymer matrix to create hydrostatic test samples. Prior to hydrostatic testing of the syntactic foam samples, it was determined that the outer surface of the casting must be removed so that single wall failure of the HSCMS on the outer surface would not occur. In use, the outer surface of the foam will always be machined to the shape needed and no spheres will be exposed to pressure through a single shell wall, the weakest point of this type of foam. Samples were lathed to remove the outer layer. Hydrostatic soak testing of the syntactic foam larger samples was done starting at 3000 meters and increasing 1000 meters at a time if the samples did well at the test pressure.

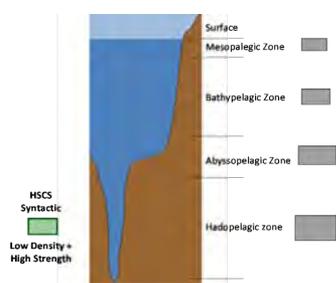
Results

The performance of the HSCS during the hydrostatic crush testing show the potential for this technology to produce the 30.0 pcf foam for this application. Much of the foam within the test sample survived up to the 24,000 psi limit of our test chamber. Optimizing the fabrication, density and processing of these HSCS could yield a very large window of potential to reach the density and performance desired for this application.



Impact

The lightweight syntactic material performed to an extent that shows a great potential for achieving 30.0 pcf, +6500 meter, man-rated performance. Hollow silicon carbide spheres provide for a wider window of opportunity for achieving the desired foam performance for current and next generation deep sea submersible vehicles.



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Project Title: "Re-enforced Hollow Silicon Carbide Shells"
 Agency: NSF, Year of Award: 2010, Contract#: IIP-1012299

Project Title: "Low Density 6500 Meter Man-Rated Syntactic Foam"
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Deep Springs Technology – Toledo, OH
 Engineered Syntactic Systems - Attleboro, MA
 Georgia Institute of Technology – Atlanta, GA
 Materials Science and Engineering

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