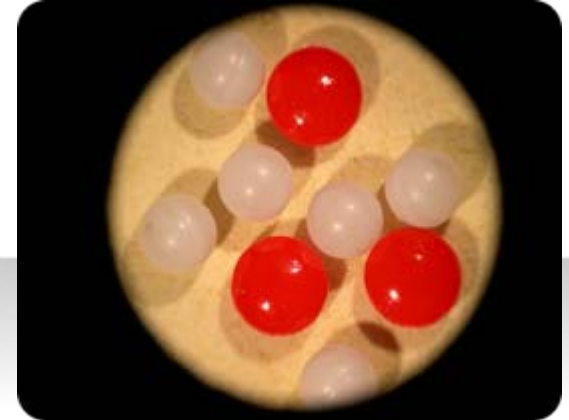


Deep Springs Technology

Company and Technology Overview



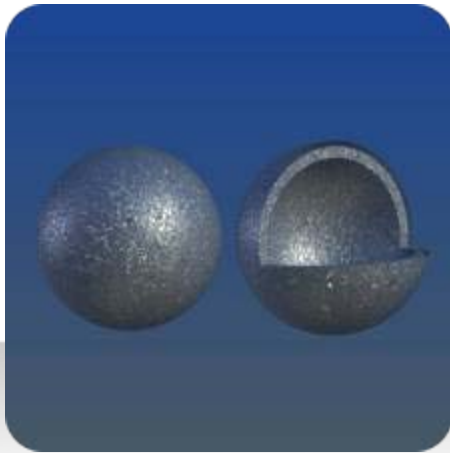
4750 W. Bancroft, Toledo, OH 43615
www.teamdst.com

DST Shells™ Presentation Overview

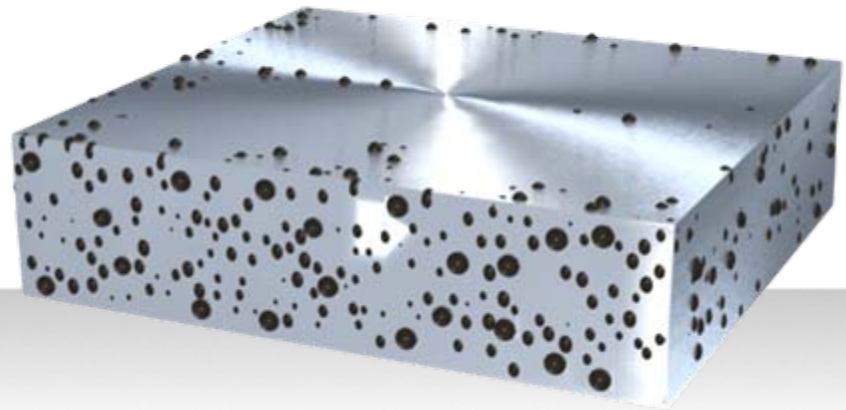
- **Introduction**
- **DST Shells™ Selectable Parameters**
- **Current Research**
- **Oil and Gas Applications**
- **Summary**

DST Shells™

DST Shells™ are precisely manufactured hollow shells for severe and demanding applications. DST Shells™ are used alone or incorporated into composite materials for other applications



**Single
DST Shell™**



**DST Shells™
Incorporated into a composite**

DST Shells™

- Engineered for the Application

10 years of R&D has allowed DST to refine its DST Shells™ manufacturing process and produce fully customizable DST Shells™ with the following parameters:

- Material
- Size
- Shape
- Density
- Optional Fill
- Layers

Customizable Options

Material Diversity

Ceramic

Silicon Carbide

Alumina

Boron Carbide

Yttrium Oxide

Zirconium Oxide

Mullite

Metal

Stainless Steel

Low Alloy Steel (4140)

Maraging Steel

High Entropy Alloy

Glass

Aluminosilicate

Borosilicate

Soda-lime

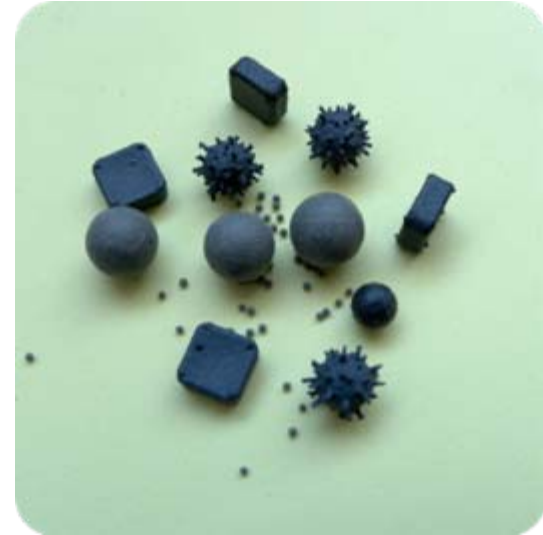
Customizable Options

Size, Shape, and Texture

Size: 500 microns to +25 mm

Shape: Spherical, Square, Rectangle, Cylindrical, and Hexagonal

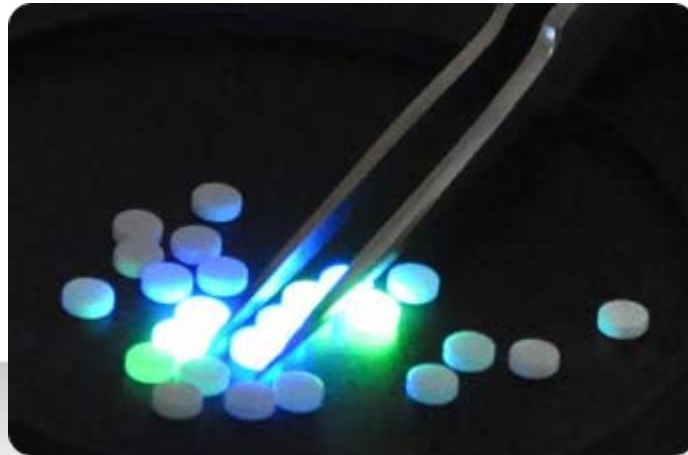
Textures: Smooth and Whiskers



Customizable Options

Filling

DST Shells™ can hermetically encapsulate gas mixtures at controlled pressures including a vacuum

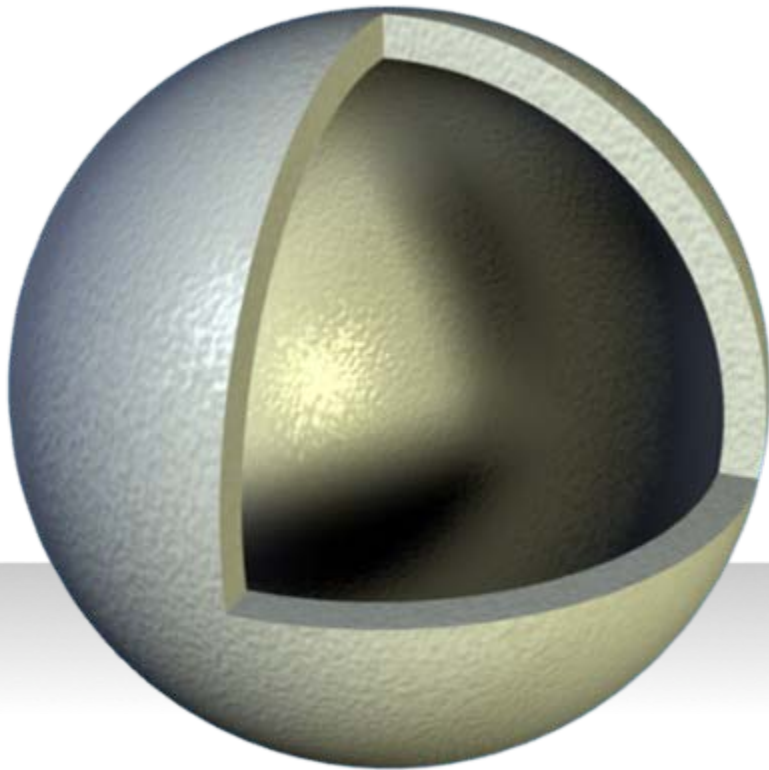


3mm disks filled with Neon for display applications

Filling DST Shells™ with liquids or powders may be possible

Customizable Options

Density



Controlled Densities

Densities as low as .25 g/cc

Heavier Shell Materials

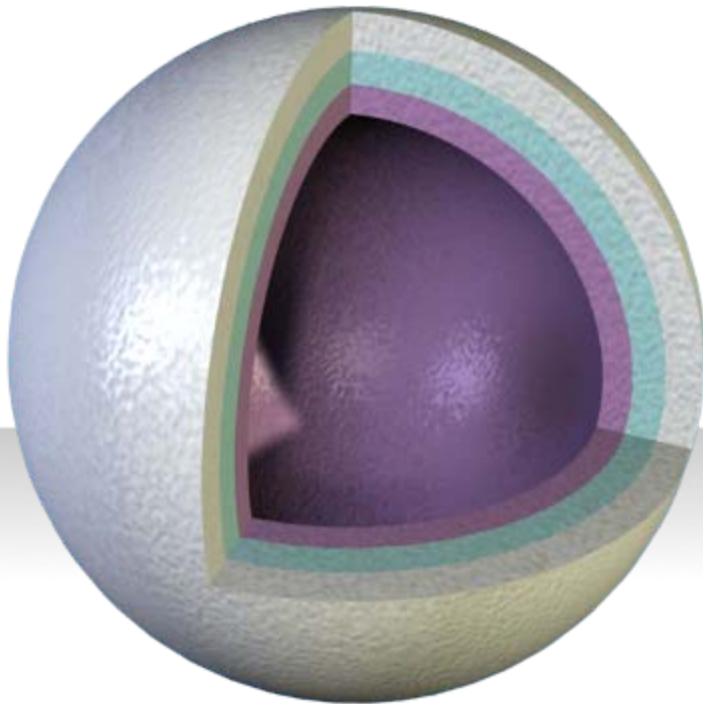
Light weight Shell Materials

Thicker walls

Thinner wall thickness

Customizable Options Layering

DST Shells™ can be layered with different materials.



Layering

Improves bonding and adhesion issues

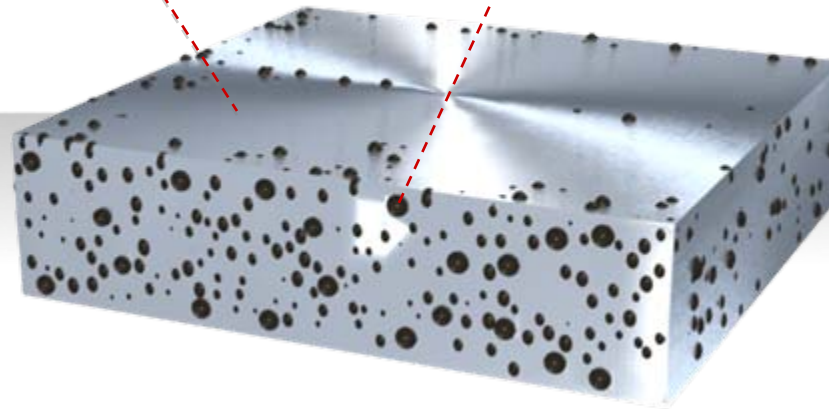
Creates novel surfactant solutions

Improves structural integrity of shells

Customizable Options Matrix Composites

Aluminum Matrix

Hollow Spherical Shell



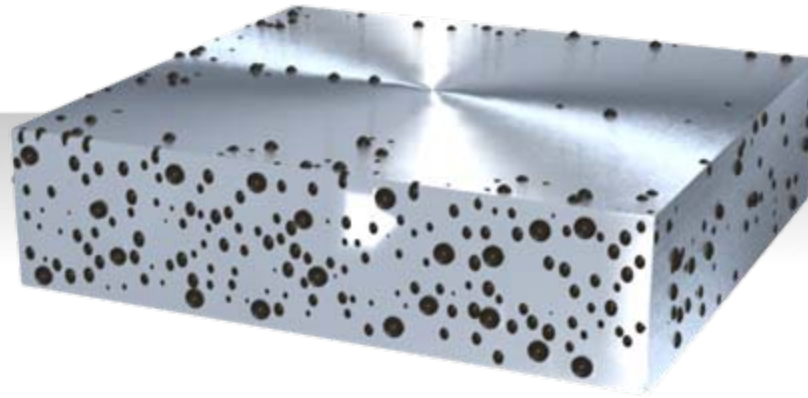
Composite Parameters

Composite matrix parameters can be specified including:

Fill Factor

Packing Geometry

Material



Composite Material Options

Ceramic Matrix

Ceramic DST Shells™

Metal Matrix

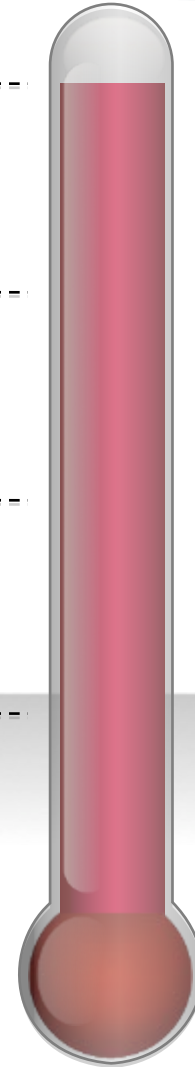
Metal and Ceramic DST Shells™

Glass Matrix

Glass, Metal, or Ceramic DST Shells™

Polymer Matrix

Glass, Metal, or Ceramic DST Shells™



***What applications benefit
from DST Shells™?***

DST Shells™ Research Developments

DST is actively engaged in supporting customer research efforts for diverse applications...

- **Proppants**
- **Buoyancy**
- **Light Weight/Impact Tolerant Material**
- **High Temperature Insulation**
- **Water Purification**

DST Shells™ for Proppants

DST Shells™ have been successfully manufactured for specific well bore applications.

Materials include

- Metal
- Silicon Carbide

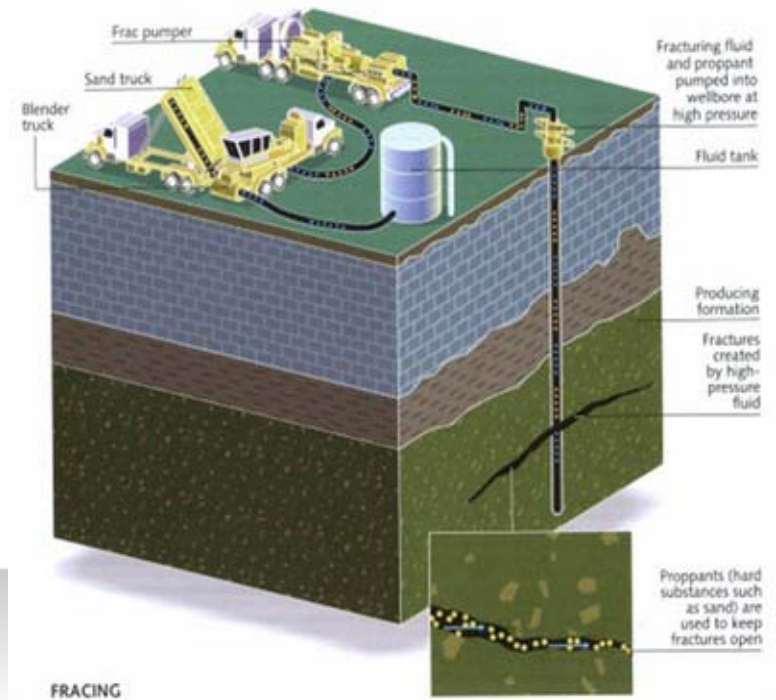
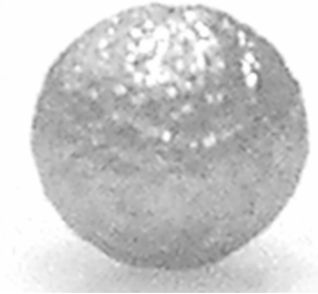


Photo EPA

Metal DST Shells™ Deform



0% Strain



50% Strain



75% Strain

Metal DST Shells™ deform under pressure without shattering

Deformation does not produce well clogging “fines”

Buoyancy

Silicon carbide and other ceramic DST Shells™ are strong *and* light weight. Ceramic DST Shells™ are put in a polymer matrix, and provide a positive buoyancy to counterbalance submersible component weight.

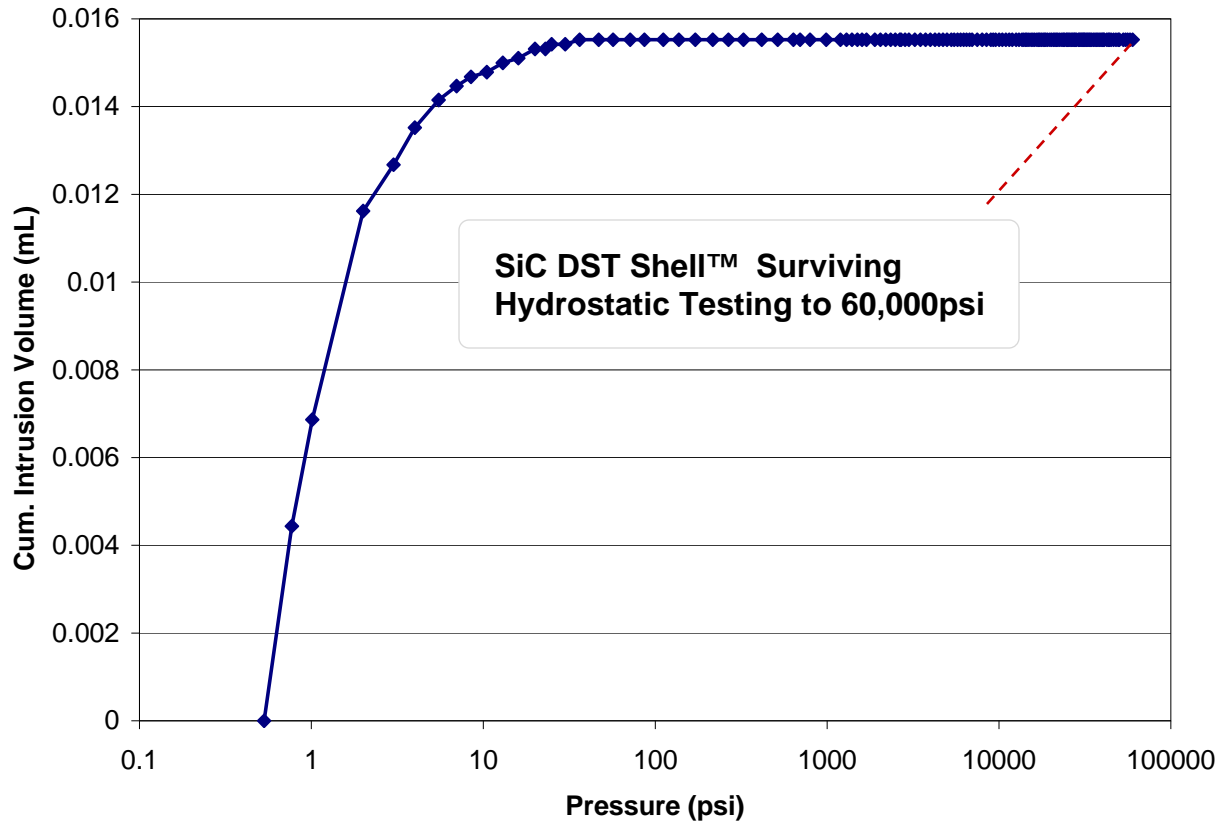
Customer Testing – Deep water buoyancy module weight decrease of 3 to 5 pcf using DST Shells™ compared to glass only systems.



Hollow Shells – SiC (0.24 g/cc)

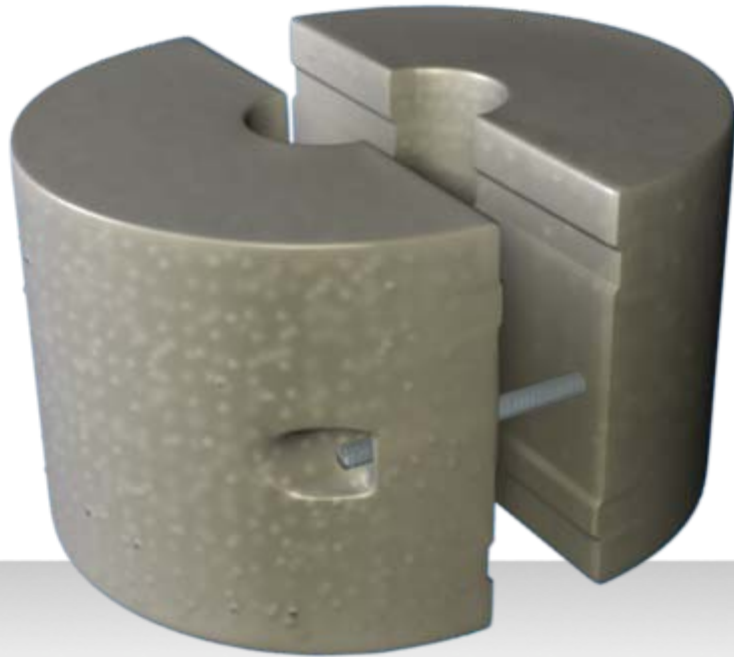


High Strength / Low Density DST Shells™ for Buoyancy Applications



Hydrostatic Crush Strength – Tested in a Hg Intrusion Porisimeter

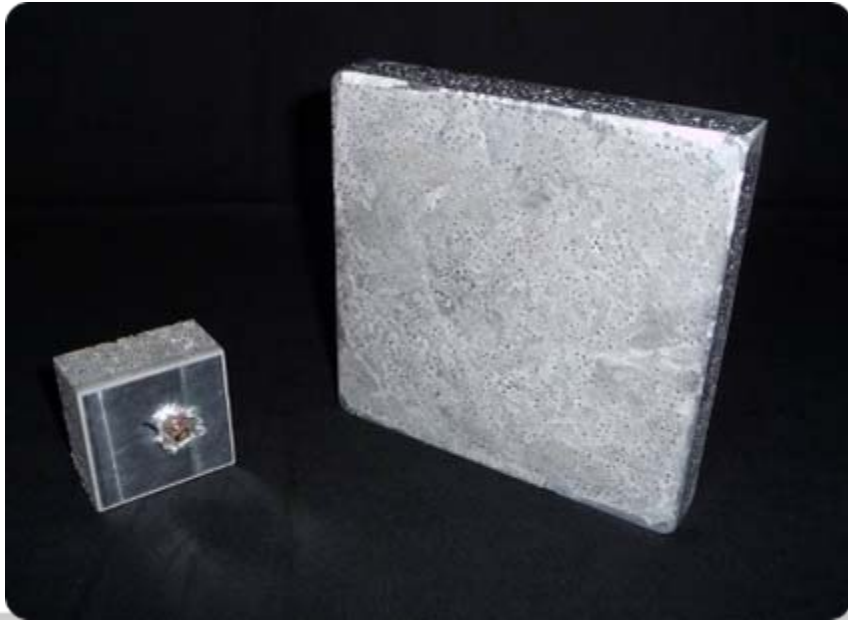
DST Shells™ for Oil and Gas Industry Buoyancy Applications



**DST Shells™ can be used as buoys
and provide insulation for flow lines**

Concept drawing of DST Shells™ in a composite for flow line buoys

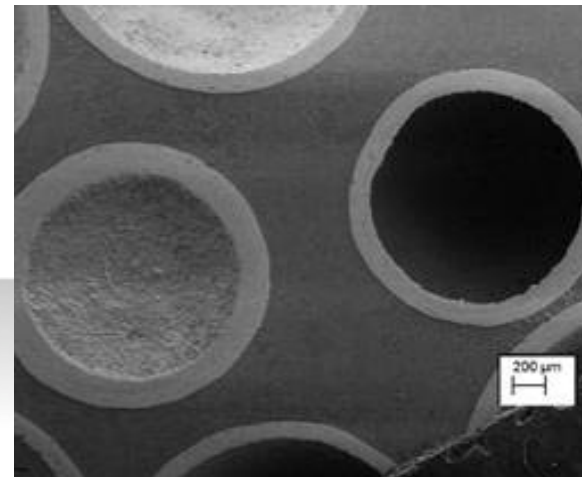
Light Weight/Impact Tolerant Material



Ceramic and metal DST Shells™ are embedded into various matrices to produce shock absorbing materials for automotive and military applications.

DST Shells™ reduce weight while retaining structural integrity.

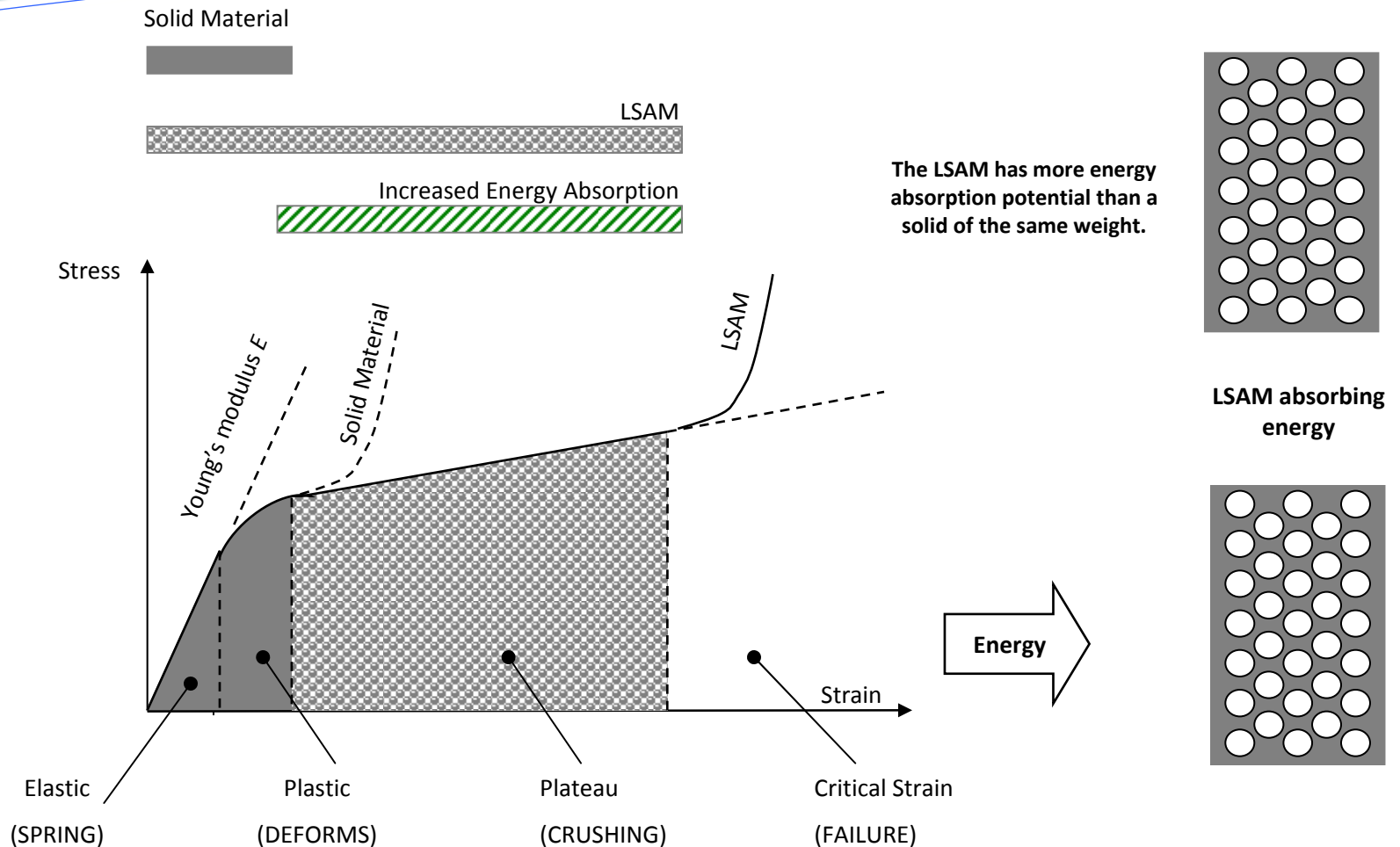
DST Shells™ are being evaluated for armor applications by ARL, ONR, and DARPA.



Steel DST Shells™ in an Aluminum Matrix

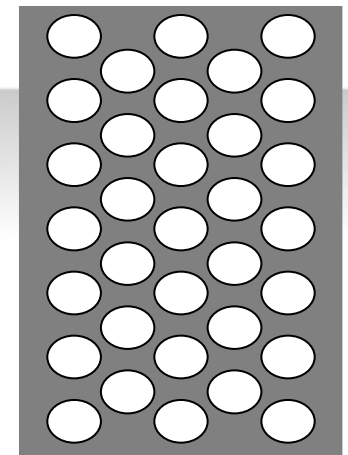
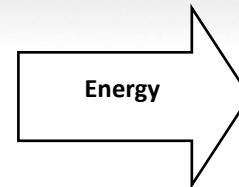
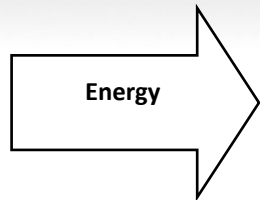
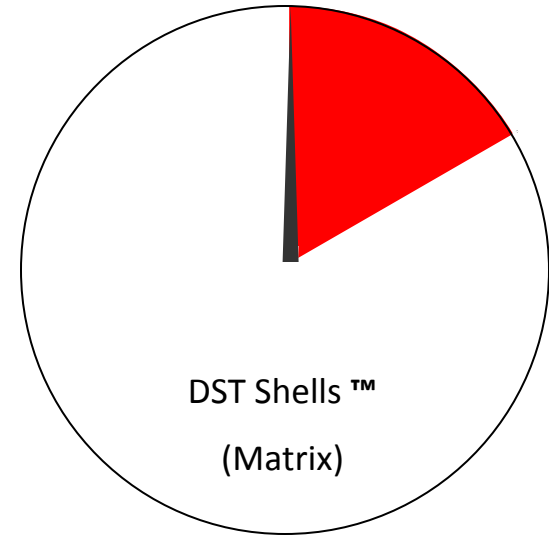
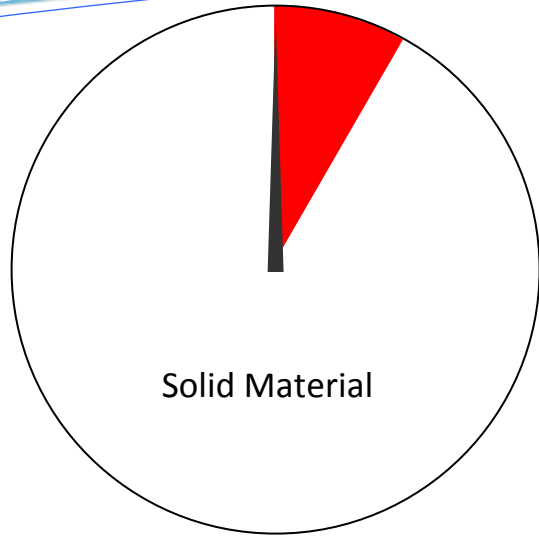
Energy Absorption

DST Shells™ in a matrix have greater energy absorption and a 15% to 25% reduction of weight as compared to a similar solid material.



Energy Absorption

DST Shells™ in a metal matrix



Light Weight /Impact Resistant Materials

Benefits to Oil and Gas Industry

Reduce component weight on platforms

Provide protection against collision



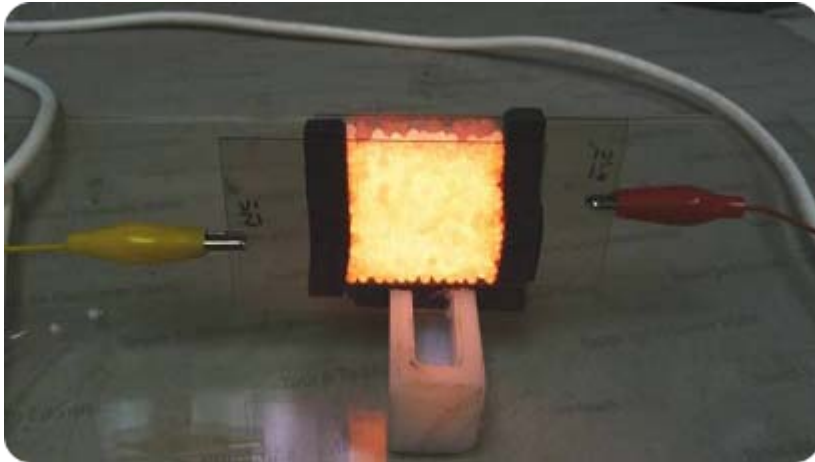
High Temperature Insulation



DST Shells™ are being produced in many different configurations for applications in high temperature insulation

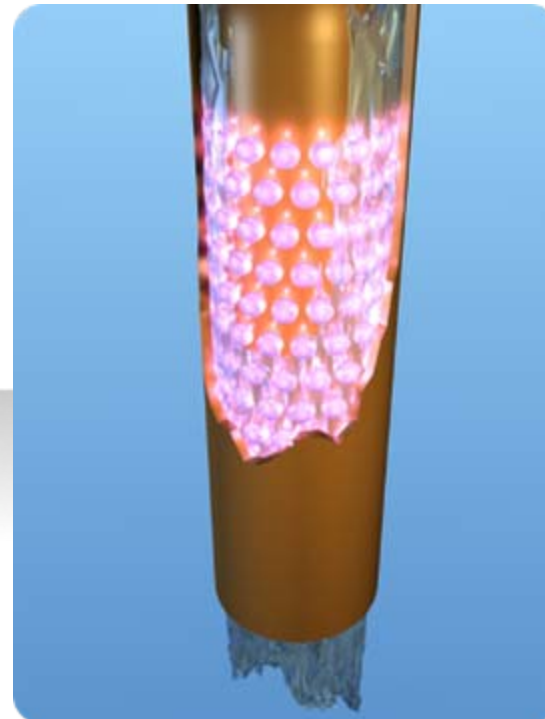


Water Purification



DST Shells™ energized between two plates of glass

DST Shells™ are packed between two tubes which capacitively couple energy into the spheres



Water is passed between the two tubes and is purified by the UV DST Shells™

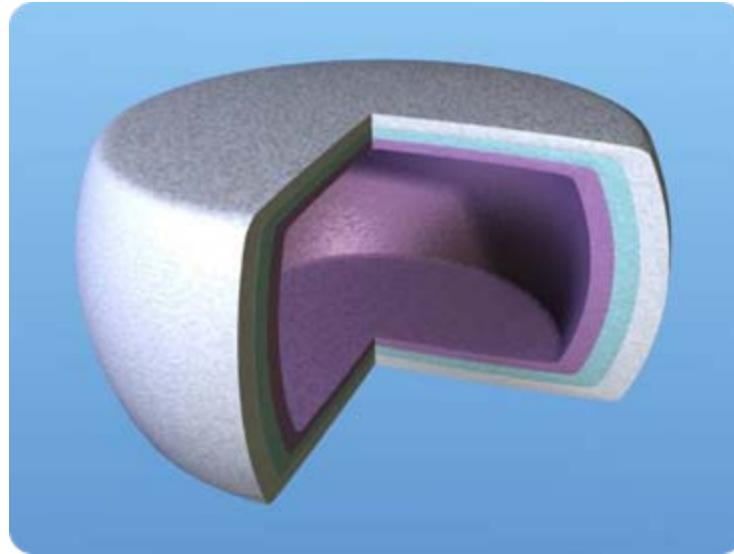
DST Shells™ Applications in Oil and Gas Industry

- **Well Aids**
- **Surfactant Delivery**
- **Spill Clean-up**
- **Thermal Insulation**

Well Aids

- Tracers can be enclosed in DST Shells™
- Well zone isolation
- Slow release agents can be put inside DST Shells™ or on the outside as a coating
- DST Shells™ may be coated for surfactant applications

Surfactant Delivery and Spill Clean-up



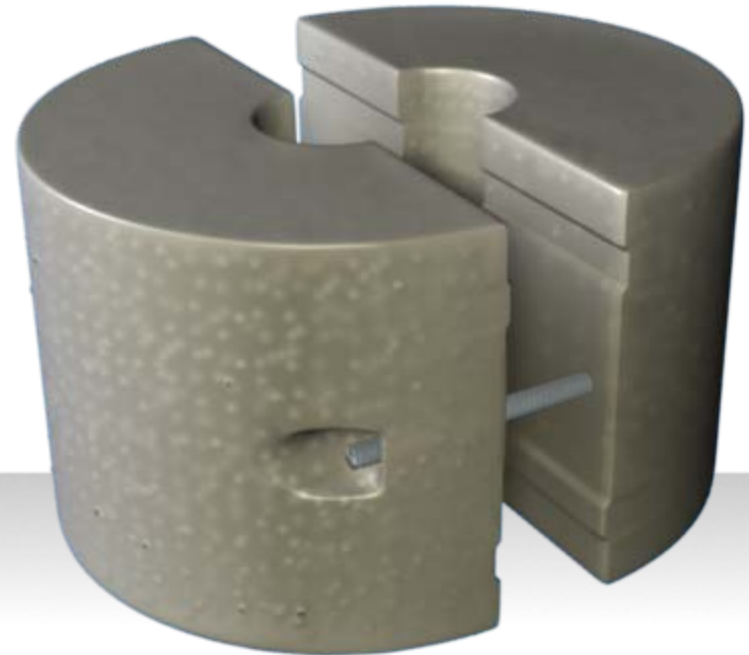
Shells coated/filled with chemicals may be used as buoys to absorb oil or surfactants.

Flow Line Insulation

DST Shells™ Can be put in high or low temp matrix foams. Higher pressure resistance allows it to be used for deeper applications

Vacuum inside shells provide for thermal insulation

DST Shells™ can be used with glass bubbles for increased benefits



What can I do with DST Shells?

Explore novel solutions to problems that were not solvable, or too expensive to solve.

Realize the opportunity for increased efficiency in oil and gas recovery and processing and greater profitability.

Summary

DST Shells™ are an enabling technology that support many applications. DST Shells™ have many customizable parameters, that make it possible to tailor to a myriad of applications. Over the past 10 years DST has developed its shell technology to the point that the Oil and Gas industry can quickly benefit and realize significant improvements in existing and new applications.