

# Deep Springs Technology

## Company and Technology Overview





## **Background**

- Toledo, Ohio based company established in 2007
- Office / Lab Space 11,500 sq. ft.
- Currently engaged in
  - Research and Development, Hollow Shell and Syntactic Foam
  - Introductory product sales
  - Toll Services

## **Highlights of 2007 to 2010**

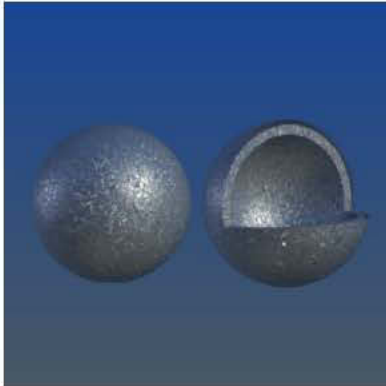
- Increased employment - 4 full time research professionals to 8 full time as well as co-op students.
- Government sponsored research with NASA, NIST, ARL, and NSF.
- Commercial customers currently sampling product for thermal, armor, buoyancy, and structural applications. Materials, Honda USA.

## **Enabling materials technology suited for multiple markets:**

Oil & Gas  
Offshore / Deepwater  
Aerospace  
Defense  
Automotive

## Hollow Shells

Hollow shells are continuous structures that encapsulate a void.  
The shell wall can be impervious or porous for the application.



**Made of various materials:**

**Ceramic** - SiC, Al<sub>2</sub>O<sub>3</sub>, B<sub>4</sub>C, Y<sub>2</sub>O<sub>3</sub>, ZrO

**Metal** - Steel (Low Alloy), Maraging Steel

**Glass**

**Fabricated into controlled shapes**

**Densities as low as .25 g/cc**

**Diameters as small as 400 microns  
(typical sizes one to four millimeters)**



## High Strength / Low Density Hollow Shells for Oil Well proppants



The successful outcome has been the identification of materials compatible with a flexible manufacturing process that can provide large quantities of low cost hollow metals spheres tailored to individual well bore applications.

DST is engaged in research and development of the underlying technology required to produce proppants for the oil and natural gas industry.

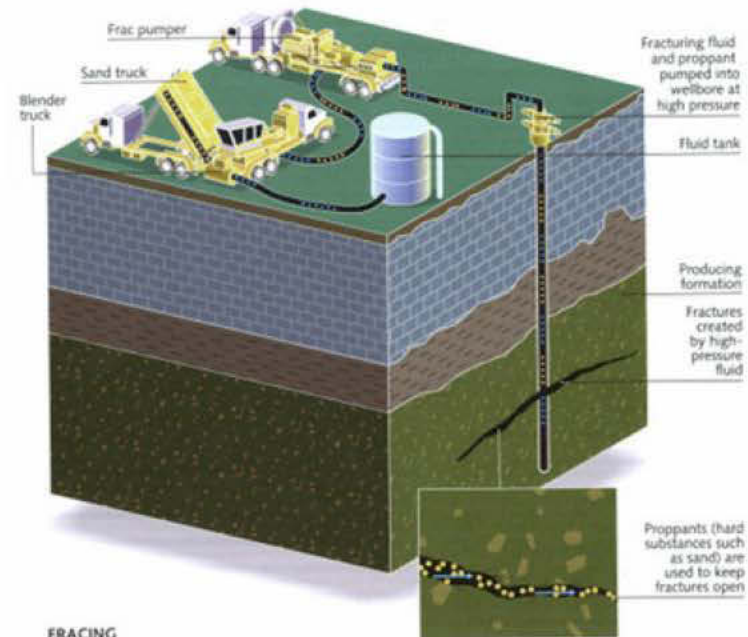


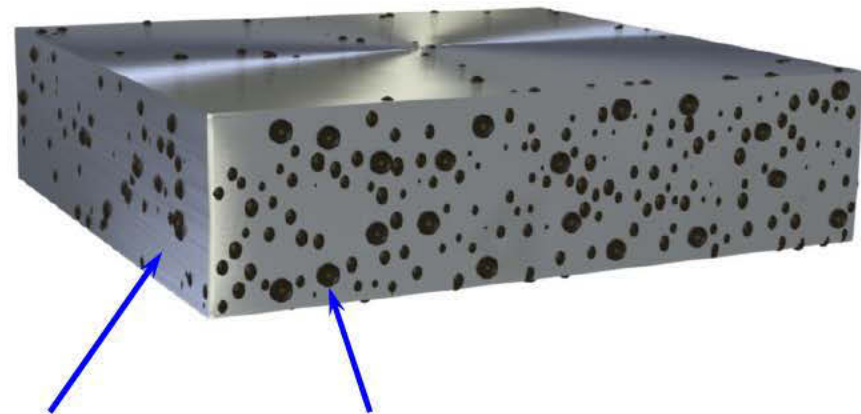
Photo EPA

## Syntactic Foams

Syntactic foams are composite materials composed of hollow shells embedded in a matrix

Applications include:

- Deep sea buoyancy foams
- Thermoforming plug assist
- Radar transparent materials
- Acoustically attenuating materials
- Blast mitigating materials



Processing Temperature Low $\longrightarrow$ High	Matrix	Possible Shell Material
Polymer - Glass - Metal - Ceramic	Polymer	Glass, Metal, Ceramic
	Glass	Glass, Metal, Ceramic
	Metal	Metal, Ceramic
	Ceramic	Ceramic

## High Strength / Low Density Hollow Shells for Armor Applications

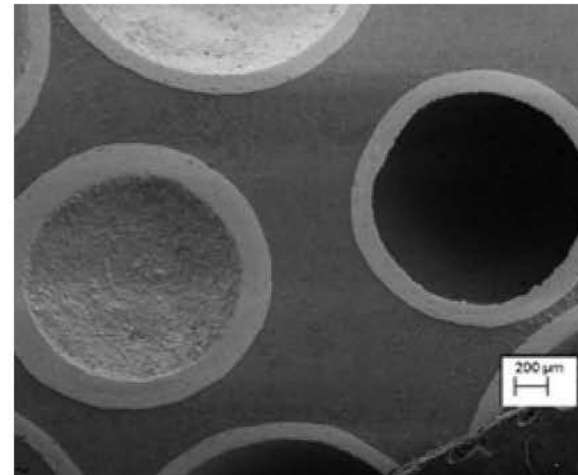


**LSAM – Lightweight Syntactic Armor Material**

Portions of the research reported in this presentation was performed in connection with contracts W911QX-09-T-0151 and W911NF-10-2-0084 with the U.S. Army Research Laboratory. The views and conclusions contained in this presentation are those of the authors and should not be interpreted as presenting the official policies or position, either expressed or implied, of the U.S. Army Research Laboratory or the U.S. Government unless so designated by other authorized documents. Citation of manufacturers' or trade names does not constitute an official endorsement or approval of the use thereof. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation hereon.

Armoring concepts must adapt to meet the changing requirements of the battlefield. Designers must reach weight reduction goals by finding materials with higher mass efficiencies (strength to weight).

In response to requirements for high-strength, lightweight materials for armor applications DST is developing a new class of armor composite material.



**Hollow steel shells in an aluminum matrix**

## High Strength / Low Density Hollow Shells for Buoyancy Applications

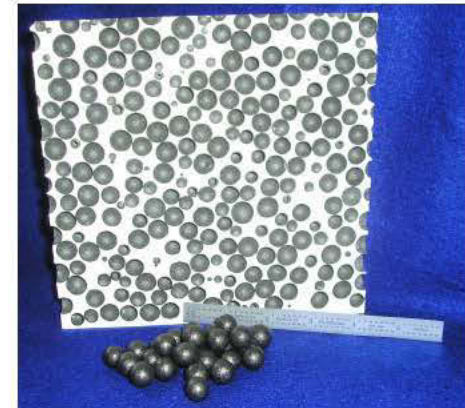
Hollow sphere technology is a critical component of syntactic buoyancy foam for deep diving submersibles. The weight and volume of the foam itself is an important consideration.



Hollow Shells – SiC (0.24 g/cc)

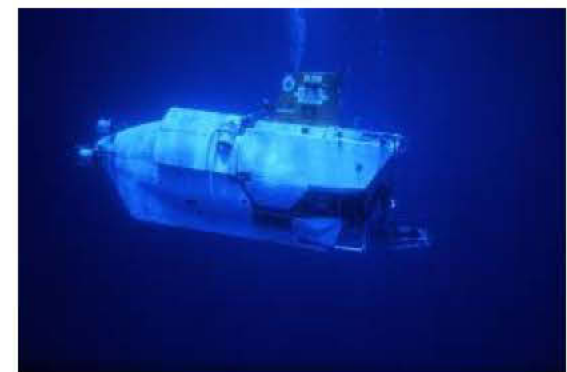
DST manufactures hollow spheres capable of withstanding hydrostatic compressive forces in excess of 60,000 psi. DST hollow shells can also obtain low densities (< 0.30 g/cc) in the target size range of 3 mm diameter.

Photo ESS



Syntactic Buoyancy System

Photo Woods Hole



ALVIN Submersible

## **Benefit to Ohio communities**

- Utilizes both scientific and labor talent.
- Technologies compatible with Ohio's existing manufacturing infrastructure.
- Company is on a growth trajectory.
- Strong patent portfolio & proprietary processing techniques allows DST to compete on a global level.
- Diverse markets reduce cyclical effects.

## **Vision for 2011 and beyond**

- Scale up of manufacturing process (in progress)
- Continue development of products and processes under current contracts.
- Working directly with customers to develop custom solutions.
- Successful testing of hollow shells and syntactic materials for new markets.
- ISO Certification for transition to commercial production.