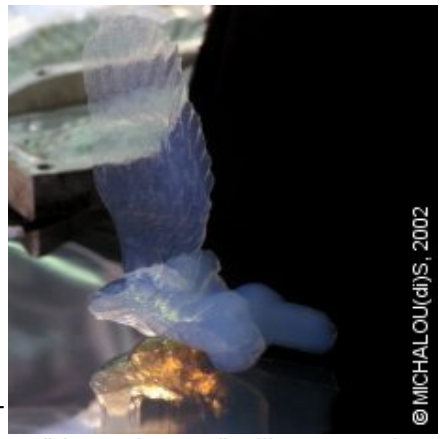
Sculpting… air

Aerogels are remarkable materials with unprecedented physical properties that fascinate researchers and space engineers. They have incredible insulating properties with regard to thermal, electrical and acoustic energy transfers. After being used by NASA in various space experiments to capture cosmic dust, aerogels became, for the first time, the object of sculptural research. Dr. Iannis MICHALOU(di)S, Research Affiliate at the Center for Advanced Visual Studies at MIT tells us the story.



"-Icare, Icare…", silica aerogel
aer( )sculpture, 7.5''x4.5''x4'',
California, 2002
photo: MICHALOU(di)S
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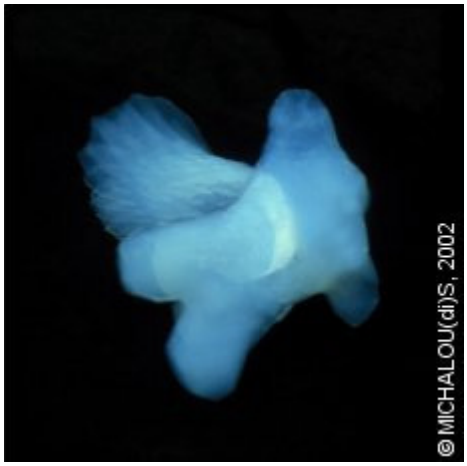
SG: When was this project started?
MICHALOU(di)S : Three years after completing my doctorate in Visual Arts, in 2001, I was invited by the founder of "Sky Art", artist Otto Piene and the Director of the MIT's Center for Advanced Visual Studies physicist Steve Benton, to conduct post-doctorate, artistic research with the title (*Nephele)*[3]*, Nephele to the third power*. In Greek νεφελη (nephele) means "cloud", and the objective of this project is to realize what seems unrealistic and crazy: a cubic cloud, a cloud which is delimited in space by six square immaterial planes.

SG: Aerogels are exciting materials for physicists and researchers but how does an artist get in contact with it? How was the idea of using aerogels as a sculptural medium born in your mind?
MICHALOU(di)S: In my collaboration with scientists and engineers at MIT, I had a very interesting discussion with the researcher Adam Whiton, when he showed me a small piece of Silica Aerogel... I stood in awe!!!…
It was Thursday, October 11, 2001 exactly one month after the disaster in New York and only nineteen days after my arriving at the Center...
That was it! Looking for clouds I had found Aerogel! Immediately, I thought of creating immaterial, ethereal sculptures with it. I knew nothing about this material and the difficulties of its expensive fabrication, but I was certain that I would have something to do with it. I was so surprised by the appearance of something that you're not quite sure is there! To believe your eyes, you need your hand and not only to touch, but also to handle, to move around, to press the material...Thus you discover that it is so lightweight and fragile...

SG: What makes aerogels so different in your perspective?
MICHALOU(di)S: Silica Aerogel has no definite geometrical form! When you look at a piece of this substance, it's up to you to decide where to focus your eyes. We can say that the space of Silica Aerogel is a personification of what Henri Poincaré named a "representative space"[1], a space that you cannot measure, you just live in with all your senses. This vaporous and fragile substance breaks the conventional boundaries of the euclidean space…The first time you look at sculpture made of this extraordinary material you think that it is not a 3-D object, you think that it is a gas, a projection, a hologram. However, this nebulous mass -that is also an optical, a tactile and a kinetic space- is there, like a memory, like a dream. It's like all the veils of the bride are there without loosing its mysterious and indefinite character.



The *aer( )sculpture* looks like a ghost image, like a 3-D X-ray

You believe that it's an illusion, but the sculpture is there, waiting for you're the tips of your fingers; After seeing this ghost image, the first thing you want to do is to touch it! It's hard to believe it's a solid! And it is indeed the lightest solid in the world because 99% of it is just pure air! Therefore, the title of this research has the name of *aer( )sculpture*.

SG: How long does it take to materialize…the immaterial aerogel sculpture?
MICHALOU(di)S : The first time I saw the cloudy and dreamy Silica aerogel, I was working also on the theater project *(Nob)Odyssey*, so I started seriously to work on the *aer( )sculptures* in the middle of January 2002, when I found a photo of Dr.Peter Tsou at NASA's J.P.L with a cube of Silica Aerogel. I had also a contact with Dr.Arlon Hunt at Berkeley Lab who gave me the name of Dr. Larry Hrubesh at L.L.L and through him I found Dr. Michael Droege at "Ocellus Technologies" in Livermore CA. I visited him at the end of May 2002. After our meeting and receiving the info I needed for the casting of Silica, I returned to Europe, where, in Paris and Athens, I produced the molds for the first *aer( )sculpture*. The molds were sent to California, and in September I traveled there for the second time in order to work on the last details of the first Silica Aerogel sculpture ever made!

SG: As far as we know this is, indeed, the first attempt to use aerogels in art. Did you already exhibit some of your realizations?
MICHALOU(di)S: The 15th of October, at the "Sky Art Conference 2002" I exposed and presented the first *aer( )sculpture "-Icare I care..."* at the European Cultural Center of Delphi in Greece. Scientists and Artists were surprised by the originality and the visual qualities of this work.

SG: Have you have frozen the blue sky by using aerogels? Did you finally obtain your goal?
MICHALOU(di)S: The objective of this project is to have these lightweight sculptures hanging in the air with the help of magnetic fields. Imagine an "Aphrodite" out of Aerogel free of its pedestal, suspended in the air…
Concerning its color, it's blue for the same reasons that sky is blue, so if you keep a piece of native silica in your hand, is like you have a piece of sky between your fingers!…
Nevertheless, when this diaphanous cyan is placed on the same line between your eye and the light, then a complementary orange color replaces the color of the sky, as Icarus it has also an orange-gold substance…
Its' sky now, is a sunset sky…

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[1]cf. Arthur Miller, Einstein-Picasso: Space,Time and the Beauty that causes Havoc, (2001), transl. in Greek S.Pierris, edit.P.Travlos, Athens 2002, pp.175-234.

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aer( )sculptures

«The Aerogel sculpture is a promising project because of potential advances toward minimal weight of 3D artworks which Ioannis Michaloudis hopes to suspend "in mid-air" via directed and quantified magnetic fields (see Klein-Ruhnau "air-architecture")».

Otto Piene, Founder of Sky Art

photos of the first Silica Aerogel sculpture ever made!

"-Icare, I care…", silica aerogel *aer( )sculpture*, 7.5''x4.5''x4'', California, 2002

On the background we see the two half of the wing mold. As far as the ''orange sunset''color, is coming from the reflection of the *aer( )sculpture* on a sheet of PVC.

photo: MICHALOU(di)S,

The body of Icarus seen from behind. The left “arm” is broken during the de-mold procedure of 09/21/02 and the color of the Silica is violet because of a warm lighting.

photo: Michael Droege,
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Dr. Michael Droege’s hand holding the body of Icarus (4’’x 2.5’’x1.5’’),

photo: Michael Droege,
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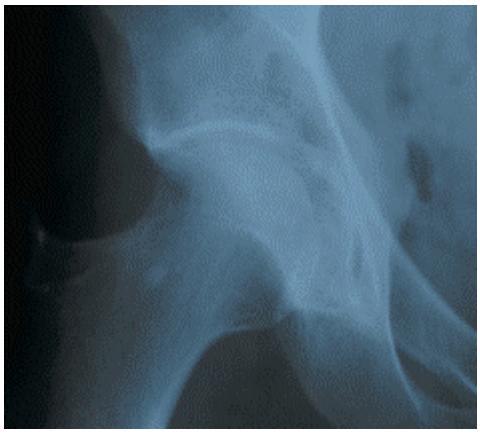
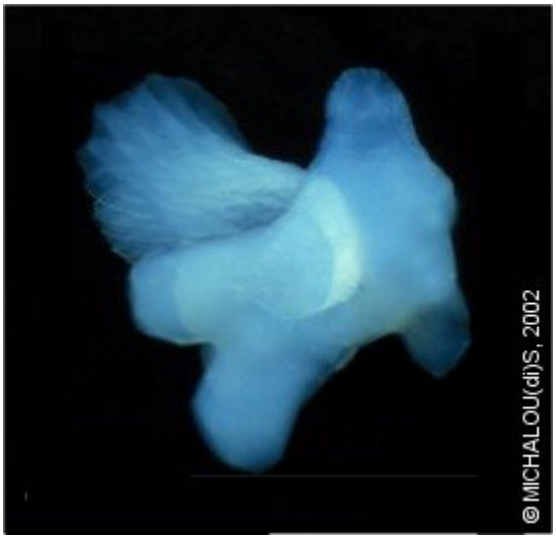
Dr. MICHALOU(di)S hand, touching the final *aer( )sculpture –Icare, I care…*

photo: MICHALOU(di)S,





The *aer( )sculpture* looks like a ghost image,like a 3-D X-ray: same color, same indefinite transparency, same "representative''
(and not euclidean)
space.

About the Artist

Dr. Iannis MICHALOU(di)S was born in Greece in 1965. He holds a diploma in Fashion Design from the Ecole Supérieure des Arts Décoratifs (Arts Decos) in Paris, and a Master of Visual Arts from the University of Paris I (Sorbonne). He received his Ph.D. in Visual Arts in 1998 from the same University. Michalous is currently a Research Affiliate at the Center for Advanced Visual Studies at MIT. His research *(Nephele)3* focuses on the creation of immaterial, ethereal works of arts using the sculptural media of controlled steam and aerogels. This research is funded by the IKY Foundation, the William Fulbright Foundation, the Associate Provost for the Arts at MIT, the Council for the Arts at MIT and the Center for Advanced Visual Studies.

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aer( )sculpture

Material Preparation and Processing

by Dr. Michael Droege, Ocellus Tecnologies, CA

I. Technology Overview

A. Aerogel Materials

Porous solids such as wood, coral, and bone are common structural materials found in nature. These materials have evolved a cellular structure in which the material of the cell wall surrounds an open pore space. This porous, cellular structure, imparts unique properties such as stiffness and strength while simultaneously being a low density (lightweight) material.

Synthetic foams can be prepared from a wide variety of metals, glasses, and polymers. These foams also possess a cellular structure in which the cells are either isolated (closed-cells) or interconnected (open-cells), depending upon the production process. Organic polymer foams are well known and commonly used in the insulation and construction industries. Examples of commercially available organic polymer foams include polyurethane seat cushions and polystyrene coffee cups. Aerogels are a unique class of polymer foams that can be prepared from either organic or inorganic polymers. Aerogels typically possess a nanostructure that is composed of extremely small interconnected particles (like pearls on a pearl necklace) that have diameters of about 100 angstroms and which surround pore spaces that are typically less than 100 nanometers. This structure results in a solid material with ultrafine pore size, low density, and open-cell porosity. It is these structural features that impart the unusual acoustic, mechanical, optical, and thermal properties observed for aerogels. For example, the nanostructure is responsible for the high surface area of aerogels (350-1500 m2/g) and its very low sound propagation. The ultrafine pore size minimizes the scattering of visible light, thus aerogels can be prepared as transparent, porous solids. The high porosity and small pore size of aerogels makes them lightweight, superinsulating materials. It is the combination of these unique properties that is now being exploited by the artist.

B. Aerogel Preparation and Processing

A two-step process typically produces aerogels. Step one is a chemical reaction known as a "sol-gel" reaction that produces the aerogel structure in solution. Step two is a special drying procedure called a "supercritical extraction" that results in the final dried solid. The sol-gel reaction is well known and used commercially to produce, for example, soft contact lens. The supercritical extraction process is used commercially to purify a wide array of products, such as decaffeinating coffee, extracting fats, refining drugs, etc.

The term sol-gel describes the change from a colloid-containing liquid solution to a semisolid gel (jelly). In the case of an aerogel, the starting materials are mixed in alcohol and water; they then undergo a chemical reaction that results in transformation from a liquid to a jelly-like solid. This gel consists of the aerogel's continuous, three-dimensional solid framework while the pores of the gel hold the liquid. These gels typically have very low strength and are soft, flexible, and do not flow. The objective of the drying step is to remove the liquid from the pores while maintaining the aerogel's nanostructure. Because of the very small pore size, simple evaporation of the liquid results in very large internal forces (capillary pressure) that cause shrinkage and cracking of the gel. The use of supercritical extraction overcomes this drying problem. Under specific temperature and pressure conditions, the liquid becomes gas-like, with little surface tension, and can be readily removed from the pores of the gel without developing destructive internal forces. The result of supercritical drying is that the aerogel maintains the original size and shape of the gel, but now the pores contain only air (hence the term aerogel).

II. aer( )sculpture Materials and Processing

A. aer( )sculpture Gel Formation

To begin this artistic endeavor, we are using a classic aerogel of silica (silicon dioxide or glass). This material, originally described by Kistler in the 1930's, is well known and possesses a large body of scientific knowledge. The sculpture gel is produced by the reaction of a silane tetralkoxide with water in an alcohol solvent to produce a clear liquid. The amount of alcohol solvent in the formulation can be varied to obtain a range of densities of the gel. Control over this parameter allows the artist to achieve different visual effects such as color and translucency. This liquid is then poured into a mold created by the artist. After some time has past, the liquid transforms to a solid gel that now possesses the physical characteristics (size, shape, surface texture) of the mold. The solvent-laden sculpture is now ready for the drying process.

B. aer( )sculpture Drying Process

The solvent is removed by supercritical extraction. In this case, the highest quality sculptures are obtained by processing the gel at the supercritical point of the alcohol solvent (greater than about 250 ºC and 1200 psi). To successfully process these gels and produce an aer( )sculpture that is true to the artist's vision, we use a new, patented aerogel processing technology that allows the fabrication of precise, net-shaped, monolithic aerogels. Our method allows the simple production of monolithic aerogel with irregular shapes and surface features. This method is excellent for producing monolithic aerogels possessing artistic content. In addition, our process technology allows a significant increase in the speed at which the supercritical extraction can be performed. For example, a high quality, monolithic aer( )sculpture can be produced in only a few hours.

A key benefit of this technology is that aerogel processing time can be significantly reduced and throughput increased without sacrificing quality or appearance.

RELATED LINKS

- *aer( )sculptures* gallery
- Interview with the artist *(Iannis MICHALOU(di)S)*
- Silica Aerogels *(BNL site)*
- Ocellus Technologies
- Glass from Aerogels *(Educational)*
- Carbon Aerogels *(French Laboratory)*
  Description of the elaboration of carbon aerogels, applications and group resarch projects