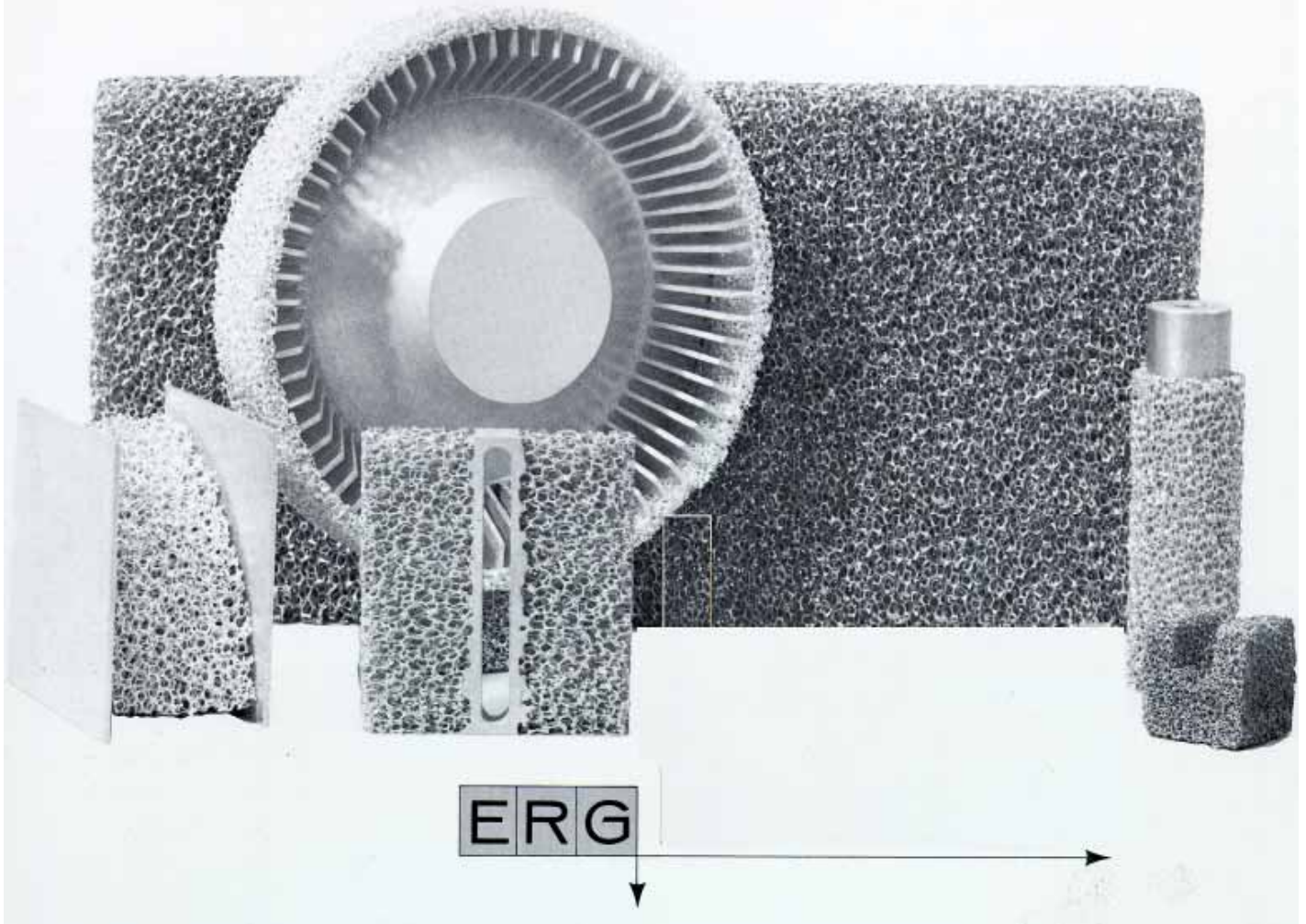


DUOCEL[®]

ALUMINUM FOAM



a basic design material . . . for the imagination

Duocel is material for the imagination. From time to time, new materials are developed—like plastics, alloys, composites—that change the way you design, even the way you think. Duocel is one of these.

Like other new materials, Duocel offers new possibilities—new and better ways of solving old problems, even ways to do things that have never been done before.

Duocel is the material for better ideas and better solutions. We've come up with the material. The ideas are up to you.

DUOCEL...true foam metal

Duocel is a true metal skeletal structure. It is not a sintered, coated, or plated product. Its purity is typically that of the parent alloy metal, with no voids, inclusions, or entrapments. There are other products that look like Duocel, but the similarity stops with the appearance.

Duocel is manufactured by directional solidification of metal from a super-heated liquidus state in an environment of overpressures and high vacuum. The resulting material has a reticulated structure of open, duodecahedral-shaped cells connected by continuous, solid metal ligaments. The solid-metal ligaments routinely test to 99 percent purity of the parent alloy (to AMS specifications), are not porous, and approximate single strand drawn wire.

The matrix of cells and ligaments is completely repeatable, regular, and uniform throughout the entirety of the material. Duocel is a rigid, highly porous and permeable structure and has a controlled density of metal per unit volume.

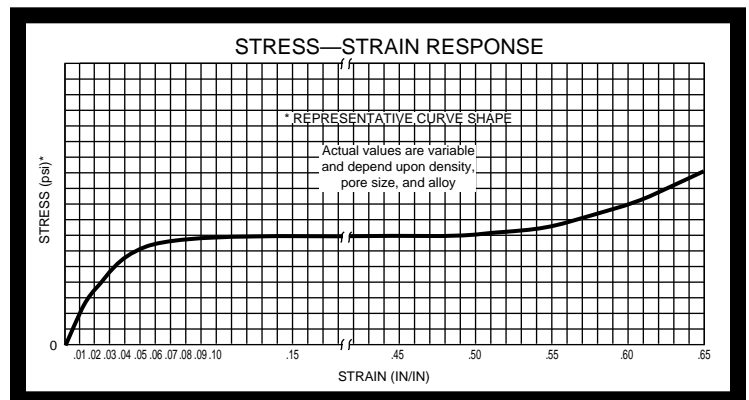
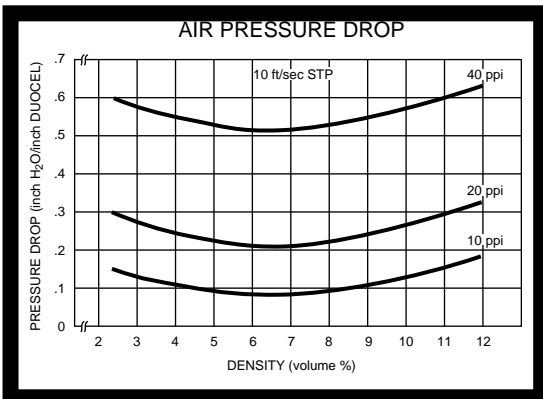
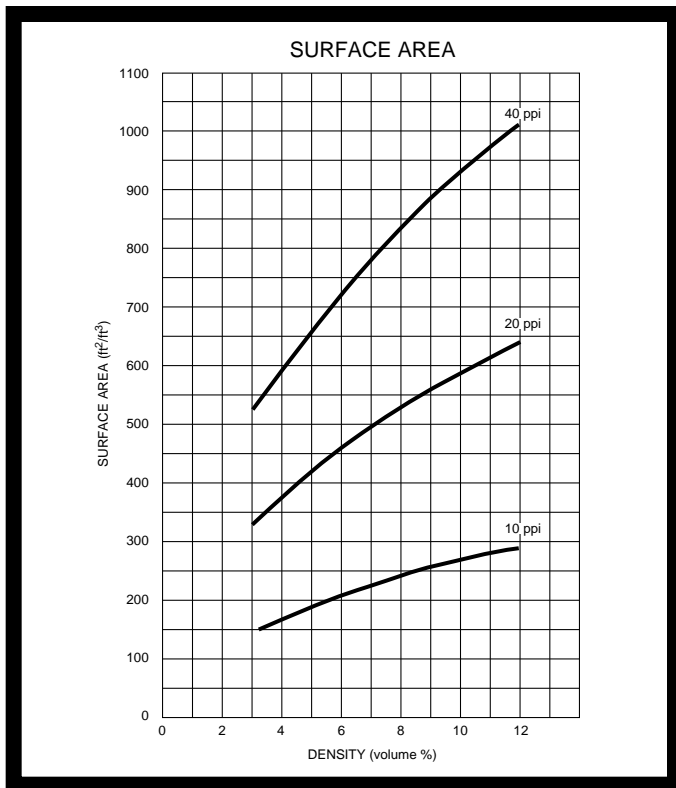
Duocel is available in production in 6101 and A356 aluminum alloys and in vitreous or glassy carbon. Other aluminum alloys, other metals, ceramics and composite materials are available on special order.

Density of metal and cell size (expressed as pores per inch) can each be varied independently to tailor the properties of the material to meet specific design requirements. Density is continuously variable from 3 percent to 12 percent. Cell size can be 5, 10, 20, or 40 pores per inch (ppi). (Mean cell sizes of .170", .080", .040", or .020".)

Duocel is manufactured in billet form in the following dimensions and then is furnished to the dimensions specified by the customer. Larger sizes are available on special order.

	Nominal (in.)
Length	16
Width	12
Thickness	4

The material is supplied as a finished end-item product to the requirements of the customer. ERG's engineering and manufacturing departments will assist you in determining how Duocel should be fabricated to meet your needs.



The “dual personality” material

ERG’s exclusive manufacturing process gives Duocel a unique “dual personality.” On the one hand, it has all of the properties of the metal of which it is made, such as corrosion resistance, intrinsic strength, electrical and thermal conductivity, acceptance of coatings, and others. On the other hand, it has the advantages offered only by Duocel: low density, high strength to weight, high porosity, extremely large surface area, and more.

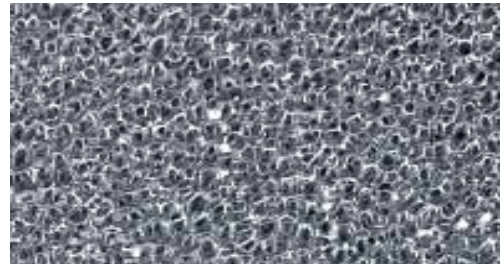
If a design calls for aluminum for its electrical properties, for example, you can have those properties with Duocel. As a bonus, you save weight (and money). Or, if weight is the critical factor, as in a heat exchanger for airborne equipment, Duocel will do the job at a fraction of the weight of a solid aluminum part.

But don’t think of Duocel as just a replacement material for existing parts. Think of it as a new basic material — one with its own set of unique properties, one that opens up a whole new way of designing.

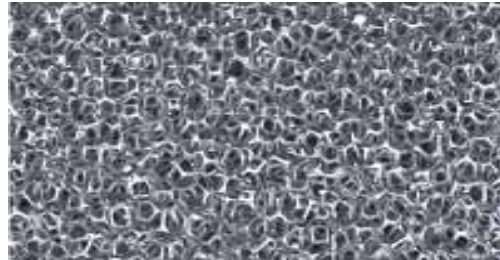
The Duocel structure provides several unique mechanical properties:

1. Independently variable porosity from 5 to 40 pores per inch.
2. Independently variable density from 3 to 12 percent.
3. High (and variable) surface area to unit volume.
4. High strength-to-weight ratio.
5. Completely isotropic load response.
6. Variable stress-strain characteristics.

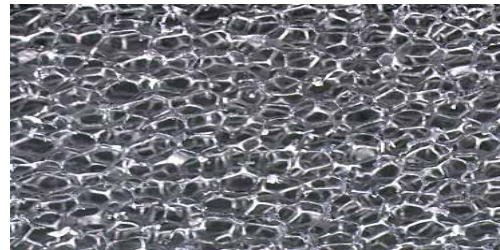
The accompanying graphs show some of Duocel's general properties. ERG’s engineering department has extensive research and engineering data for specific applications of Duocel, such as heat transfer, energy absorption, and structural applications. We will be pleased to furnish this data to you and to answer your questions about the suitability of Duocel for your application.



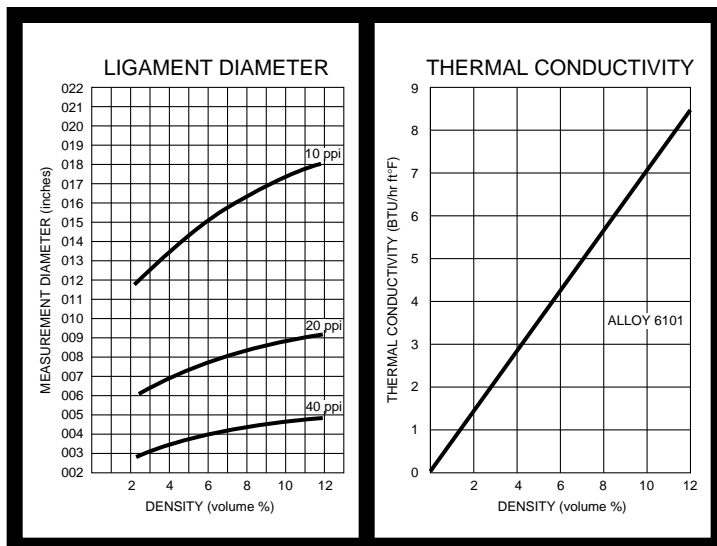
40 pores per inch



20 pores per inch



10 pores per inch



Fabrication properties and processes

Duocel can be cut, turned, milled, ground, lapped, drilled, rolled, and finished with special machine-shop equipment to normal tolerances. Through forming, Duocel can easily conform to complex shapes. Any bonding technique that can be used for the parent metal can be used for Duocel. It can be vacuum- or dip-brazed, epoxied, or adhesion bonded. Unlike other similar materials, Duocel can be brazed to metals, forming an integral metal-to-metal bond. Duocel can also be heat treated, anodized, alodine coated, or metal plated. It accepts colors, finishes, platings, and coatings just as the parent metal does.

DUOCEL applications

ERG has been supplying Duocel for industrial, defense and aerospace high-technology needs since 1968. It has met the standards of NASA manned space flight projects, naval weapons specifications, and military specifications. Some of the organizations that use Duocel and some of the applications are listed below. How many more uses can you imagine?

- Heat sinks for electronic components
- Cryogenic heat exchanger
- Heat shielding for aircraft exhaust
- Core structure for high strength panels
- Water baffle in underwater launch missile
- Containment matrix and burn rate enhancer for solid propellants
- Energy absorber for shaped charges
- Battery plates and spacers
- Aircraft wing structure
- Fuel tank baffles
- Compact heat exchangers
- Dead volume matrix in hard vacuum applications
- Gas diffusers for semiconductor etch and deposition equipment
- Porous electrodes
- Pneumatic tool muffler
- Silencer for jet engine intakes
- Electromagnetic pulse (EMP) attenuation
- Aircraft armor for fragmentation capture and absorption
- Energy absorber for blast shock wave
- Regenerator for thermal engines
- Matrix for chemical beds and scrubbers
- Mist elimination of water and oils
- Flow straightener in wind tunnels
- Air cooled condenser-cooling towers
- Fluid pulse damper
- Flash evaporator baffles in water desalination
- Filters for sea water removal in surface ship ventilation
- Energy absorber for auto bumpers
- Race car deformable structures
- Drone aircraft wet-wing structure
- Ablative sealing for compressor/turbine blades
- Liquid heat exchanger
- Catalyst surface
- Vacuum chucks

Users of DUOCEL

Aerojet Propulsion Division
Aerospace Corporation
Alliant Techsystems, Inc.
AlliedSignal Aerospace
Applied Materials, Inc.
Argonne National Laboratory
B. F. Goodrich Aerospace
Ball Aerospace
Boeing Aerospace
Chrysler Corporation
Coors Ceramics Company
Dupont Company
Eaton Corporation
Edwards Air Force Base
EG & G, Incorporated
Fairchild Semiconductor
FMC Corporation
Ford Motor Company
GenCorp, Incorporated
General Dynamics Corporation

General Electric Company
General Motors Corporation
Goodyear Tire & Rubber Company
Gould Electronics Incorporated
GTE Government Systems Corp.
Hamilton-Standard
Hewlett-Packard Company
Hughes Aircraft Company
Jet Propulsion Laboratory
Kaman Sciences Corporation
Lam Research Corporation
Lawrence Berkeley Laboratory
Lawrence Livermore Laboratory
Litton Industries, Incorporated
Lockheed Martin Corporation
Loral Corporation
Los Alamos National Laboratory
McDonnell Douglas Corporation
Micron Semiconductor, Incorporated
NASA

Naval Research Laboratory
Northrop Grumman Corporation
Orbital Sciences Corporation
Pratt & Whitney
Raytheon Company
RCA
Rockwell International Corp.
Sandia National Laboratory
Stanford Research Institute
Sumitomo Heavy Industries
Sundstrand Corporation
Teledyne Incorporated
Texas Instruments, Inc.
Thiokol Corporation
TRW Incorporated
United Technology Research Center
W. R. Grace & Company
Westinghouse Electric Corporation
Wright-Patterson Air Force Base
Xerox Corporation

Try our Imagination Kit

To help your imagination come up with new ideas for designing with Duocel, we want to send you free samples of the three standard pore sizes. Each piece measures $\frac{1}{2}$ by $1\frac{1}{2}$ by $3\frac{1}{2}$ inches—large enough for you to examine Duocel's engineering and manufacturing properties for your application. We will also be happy to quote prices on fabricating your first prototype parts and on larger sample quantities. Just use the reply card enclosed with this brochure or call us.