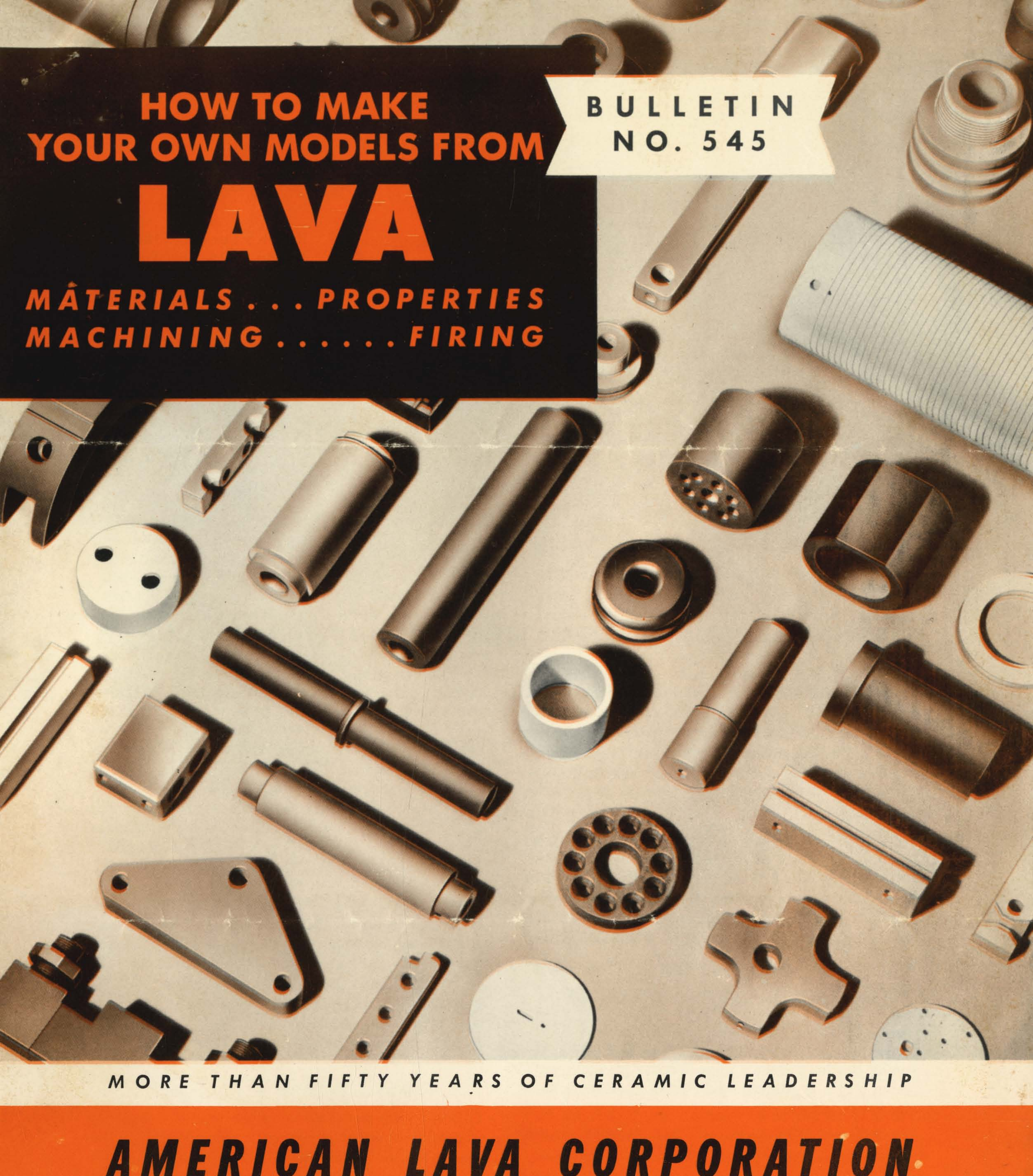
HOW TO MAKE YOUR OWN MODELS FROM LAVA

BULLETIN NO. 545

MATERIALS . . . PROPERTIES
MACHINING . . . . . . FIRING



MORE THAN FIFTY YEARS OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE, U. S. A.

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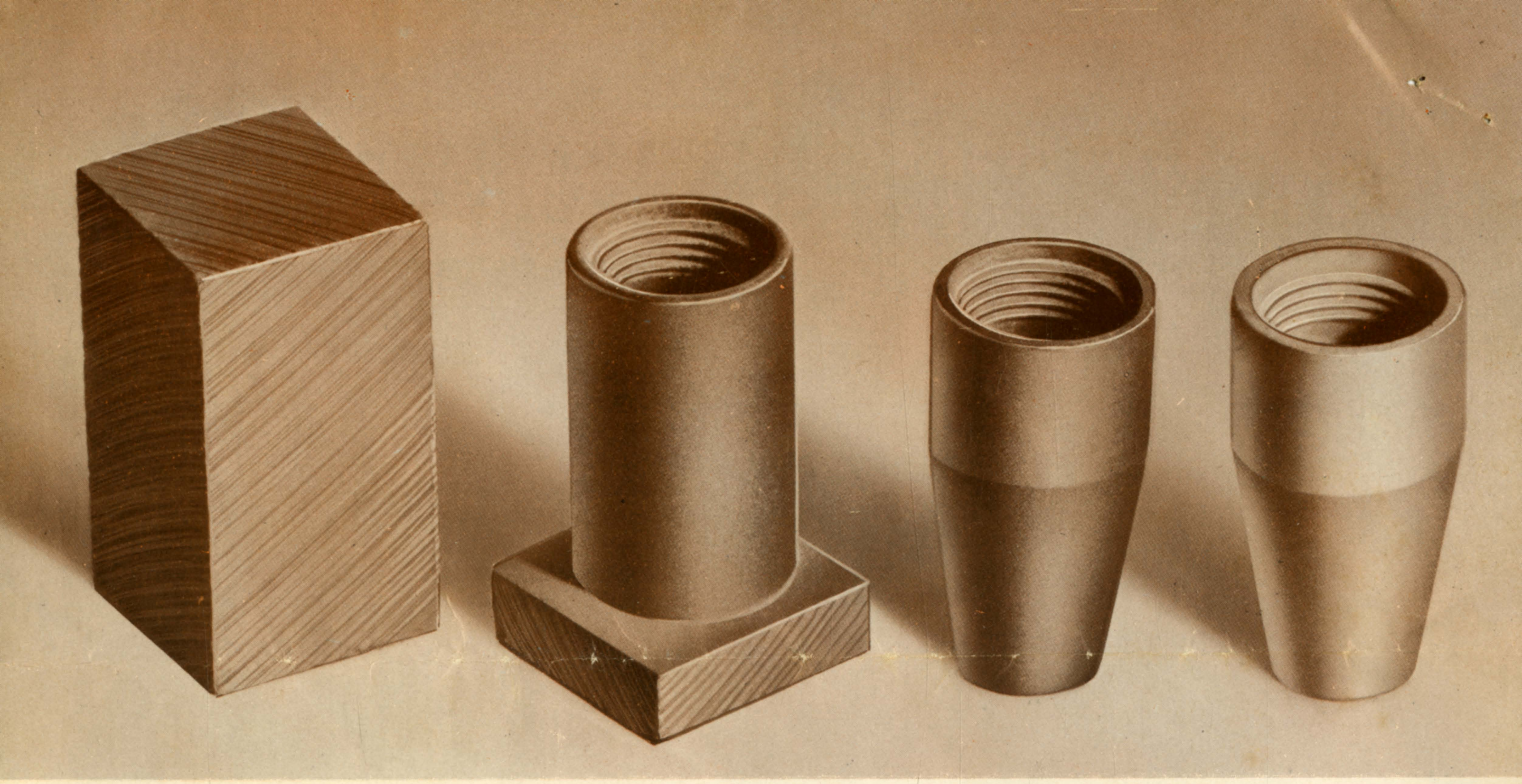
A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY



FOUR STAGES OF MODEL MAKING FROM LAVA

THE PROPERTIES AND HEAT TREATING OF LAVA

THE AMERICAN LAVA CORPORATION furnishes various grades of LAVA, in its unfired or "green" state, for model making and other experimental uses. While the company maintains a department devoted exclusively to LAVA manufacture, the customer may save considerable time by making his own models.

LAVA, a trade name for these products, is not to be confused with volcanic material of the same name, and is a species of mined nugget stone. The various grades of LAVA in the form of rough cut rectangular blocks are sold by the pound, one pound containing approximately 10 cubic inches of stone.

Three Grades of LAVA for Model Making

Three grades of LAVA are furnished. The choice between grades depends upon the use to which each is put and is predetermined by the specifications of the final product.

The different LAVA grades are designated: Grade A, Grade 1137, and Grade 1136.

LAVA, Grade A is the material most frequently used from which models are made. Chemically it is *hydrous aluminum silicate,* and is usually furnished in prisms up to a cubic foot, but can be cut to larger sizes if desired. *The articles made from this grade should not have a wall thickness over ½ inch, to avoid firing cracks.* The material is quite uniform in structure and practically free from cracks. After firing, it develops into a good electric insulator, but with a dielectric loss factor considerably higher than for steatite insulators. This should be borne in mind if it is intended for high frequency insulation.

LAVA, Grade 1137 is a domestic talc, from a deposit developed during the war. It is low in iron oxide content and therefore especially recommended for making vacuum tube insulators. It can be obtained in prisms up to 20 cubic inches, with the longest dimension not over 3 inches, the maximum size being 2½ inches by 2½ inches by 3 inches. Articles made from it should not have a wall thickness over ¼ inch.

LAVA, Grade 1136 is very similar in properties to Grade 1137, but is an imported material. It is not available in prisms as large as Grade 1137, the largest being 2 inches by 2 inches by 3 inches. The maximum wall thickness of ¼ inch should also be observed.

Machining the LAVA Part

Unfired LAVA is free machining. It can be machined like wood or brass. It is easily cut with steel saws or abrasive discs. Turning, drilling, tapping, milling, etc. may be done with high speed tools on standard machines. If available, carbide tipped tools should be used. The material is abrasive and the machines should be protected from the dust created by machining. Coolants must not be used.

FIRING converts the LAVA into a very hard material. For close dimensional control, parts may be ground after firing. Fired lava is normally ground wet.

Firing the LAVA Part

After machining, a firing operation is necessary to harden the product. During this firing operation, chemically bound water is driven off and the LAVA undergoes certain crystalline changes. Because these changes are connected with small changes in volume, heating and cooling must be done carefully to avoid cracking. Pieces have to be placed in a cool furnace, and should be protected against a direct flame by refractory boxes or baffles. The rate of heating should not be faster than 500° F. per hour.

For sections above ½ inch, the speed of heating should be reduced considerably, to approximately 300° F. per hour; and maximum or curing temperature is between 1850° F. and 2000° F. The maximum temperature should be held 30 minutes for ¼ inch or thinner sections and 45 minutes for ¾ inch sections, with intermediate sizes held in proportion. After this period, the source of heat is turned off. The fired pieces are taken from the furnace after cooling below 200° F.

Hairline cracks are sometimes noticed in fired pieces. Some of these are unavoidable and caused by cracks in the original stone. Large cracks, on the other hand, are usually caused by too rapid heating or cooling.

Heat-treating Facilities Available

Should the customer have no heat-treating facilities, AMERICAN LAVA CORPORATION will be glad to fire, free of charge, any models which the customer has made in his own shop.

Dimensional Changes Due to Firing LAVA

As a result of firing, LAVA, Grade 1137, does not change in size until a heat of 1600° F. is reached. At this temperature, it begins to shrink rapidly. At 1800° F. shrinkage is 1.4 per cent and at 1900° F. it is 1.5 per cent. The same is the case for LAVA, Grade 1136. Shrinkage occurs at about the same temperature, but with a slightly different shrinkage factor (see Property Table). LAVA, Grade A, on the other hand, expands on heating, growing larger in size after a temperature of 1200° F. is reached. The expansion reaches 1.9 per cent at 1800° F., and 2 per cent at 1900° F. Above this temperature is a negligible change in dimension. A temperature of 2000° F. should not be exceeded.

Firing Vacuum Insulators of LAVA

While the heat treatment, as described above, is the same for the three materials, Grades 1137 and 1136 should be fired in the presence of hydrogen, if to be used as insulators in vacuo. The part is heated to the maximum temperature of 2000° F. At this point hydrogen gas is introduced into the furnace and the maximum temperature maintained for ½ hour. The heat input to the furnace is then shut off, but hydrogen feeding is continued until the kiln temperature drops below 500° F. Grades 1137 and 1136 thus treated are white in color, in contrast to light brown if fired in air.

Other Available Materials

Lava models often permit a quick and accurate answer to specific research and development problems. Thus, they have an important place in developmental work.

However, it is important to remember that Lava models may give only a partial answer. AlSiMag ceramic compositions are available which have even more favorable mechanical and electrical properties. The characteristics of the more frequently used AlSiMag ceramic compositions are detailed on Property Chart No. 544 which will be sent free on request. If you do not find on this chart exactly the combination of characteristics you require, outline your problem in detail and our engineers will supply facts on the AlSiMag compositions you may find especially suited to your needs.

This table shows the more important properties of unfired and fired LAVA. Special attention to the Shrinkage Factor is recommended in order to obtain correct dimensions after firing.

PROPERTIES OF UNFIRED LAVA

ITEM	UNIT	GRADE A	GRADE 1137	GRADE 1136
Type		Hydrous Aluminum Silicate	Hydrous Magnesium Silicate (Talc)	Hydrous Magnesium Silicate (Talc)
Density	lbs./cu. in.	.098	.091	.100
Volume	cu. in./lb.	10.2	11.0	10.0
Color		Gray	Varicolored Mottled	Light Gray
Hardness	Mohs' Scale	1-2	1	1
Shrinkage Factor		0.980 Material grows, .980 inch unfired will be 1.000 inch fired	1.020 Material shrinks, 1.020 inch unfired will be 1.000 inch fired	1.030 Material shrinks, 1.030 inch unfired will be 1.000 inch fired

PROPERTIES OF FIRED LAVA

ITEM		A.S.T.M. TEST NO.	UNIT	GRADE A	GRADE 1137	GRADE 1136
Density			lbs./cu. in.	.085	.102	.102
Volume			cu. in./lb.	11.75	9.76	9.76
Water Absorption		D116-42(A)	%	2.5	2.5	2.5
Color				Pink	White*	White, Gray Speckled*
Softening Temperature		C24-35	°C. °F.	1600 2912	1475 2687	1475 2687
Resistance to Heat (Safe Limit for Constant Temperature)			°C. °F.	1100 2012	1200 2192	1200 2192
Hardness			Mohs' Scale	6	6	6
Linear Coefficient of Thermal Expansion	25-100°C. 25-600°C.		Per °C.	2.9×10^{-6} 3.4×10^{-6}	11.3×10^{-6} 11.9×10^{-6}	11.3×10^{-6} 11.9×10^{-6}
Flexural Strength		D667-42T	lbs./sq. in.	9000	9000	9000
Dielectric Strength (step 60 cycles) Test discs ¼ inch thick		D667-42T	volts per mil	80	100	100
Volume Resistivity at Various Temperatures	25°C. 77°F.		Ohms per Centimeter Cube	$>10^{14}$	$>10^{14}$	$>10^{14}$
	100°C. 212°F.			6×10^{11}	9×10^{12}	9×10^{12}
	300°C. 572°F.			2×10^{9}	1×10^{10}	1×10^{10}
	500°C. 932°F.			5×10^{6}	1×10^{8}	1×10^{8}
	700°C. 1292°F.			3×10^{5}	3×10^{6}	3×10^{6}
	900°C. 1652°F.			5×10^{4}	4×10^{5}	4×10^{5}
Dielectric Constant	1000 K.C. 25°C.	D667-42T		5.3	5.8	5.8
Power Factor	1000 K.C. 25°C.	D667-42T		.01	.0003	.0003
Loss Factor	1000 K.C. 25°C.	D667-42T		.0530	.002	.002

*Hydrogen treated. Light brown when fired in air.

Complete Property Chart giving Mechanical and Physical Data on the more frequently used AlSiMag Technical Ceramic compositions will be sent free on request. Ask for Bulletin 544

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