Alginate – Lifecasters' Gold

By Ed McCormick, ALI

One of the more mysterious yet most frequently used materials for lifecasting mold making is a product made from brown seaweed called alginate. It is extraordinarily hypoallergenic for most skin types and allows for rapid mold making in incredible detail. Though is has a few drawbacks, considering the alternatives it is inexpensive and highly reliable. Until now the literature on alginate has been sparse because manufactures' guard their formulations as securely as the US Treasury guards its bullion in Fort Knox. Here we reveal the secrets of the alchemy of alginate and discuss its strengths and weaknesses.

A Brief History

Alginic acid is a phycocolliod, (a high molecular polymer of simple sugars (polysaccharide) that displays colloidal properties when dissolved in water). E. C. C. Stanford, a British pharmacist who called it algin, discovered it in 1883. In seaweeds, algin is present as a mixed salt of sodium and/or potassium, calcium and magnesium. The exact composition varies with algal species. Since Stanford discovered algin, the name has been applied to a number of substances, such as alginic acid and all alginates, derived from alginic acid.

A compound called Fucin has been reported in the past but there is no distinction between it and alginic acid. Commercial production of alginates did not begin until Kelco, now a division of Merck, was founded in 1929 in California. Since then the alginate industry has grown with major producers being the United States, the United Kingdom, Norway, Canada, France, Japan and China. The US Navy is credited for developing it and introducing it to the dental industry as a substitute for agar.

Agar, the dental impression material used in the US and elsewhere was then only available from Japanese who produced it from local seaweeds.

For years, alginate has been a staple in pharmaceutical applications. As a hydrocolloid of vegetable origin occurring as a structural component in marine brown algae, it gives strength and flexibility to the plant. More than 20 stages of processing are required to extract the alginate from its natural seaweed source.

Kelp can grow up to 2 ½ feet a day and when fully grown can be as high as 130 feet. Kelp is harvested to extract its algin used in the production of alginate.

A Highly Useful Product

Alginate was calculated to be a US $150 million business for producers in 1995 with an average market value of US $6 per kg. Today, about 25,000 tons of alginic acid is extracted each year worldwide. In the USA, the giant kelp, *Macrocystis pyrifera* is used. It is harvested from large offshore beds off the coasts of California and Mexico.

Some 120,000 ton wet weight is gathered each year using ships equipped with cutting machinery. *Macrocystis* has the distinction of being the largest seaweed in the world. The largest attached plant recorded was 65 m long and the plants are capable of growing at up to 50 cm per day.

Alginates find their uses in varied industries, such as the food, textile, medical /pharmaceutical and cosmetic industries, but the most important consumers are textile (50%) and food (30%). In the food industry alginate is used as the stabilizer of ice cream, making the product fine, smooth, tasty, and with a good melt-resistance. It also increases the expansion rate by about 10 percent. In the bakery industry it is used as an additive in referming bread, making the bread bright and lustrous loose, soft, and not easily dried. Using it in the production of dried noodles, it will strengthen the noodle and increase the yield of the finished product.

In the confectionery industry alginate is used in the production of chocolate, milk sugar, soft agar sugar, and other high-quality sweets. When the appropriate alginate is added, it can raise the melting point of the product, improve its toughness and reduce it stickiness. In the beverage industry alginate is used to reduce precipitate. Alginate is also used for coating fruit, fish, meat and other food for preservation.

It is an important ingredient in the textile industry as well. A small quantity of alginate could is used to replace a large quantity of starch in yarn spinning. Alginate is an important additive in the printing and dyeing industry as a thickening agent for dyes and inks. In the medical industry it has a number of uses. Alginate can be used in a soft capsule for intestinal disease administration, dental impression materials, a radiography agent for barium meals, medicines for high blood sugar and gastric diseases.

Extraction and Processing

Alginate can be obtained from fresh (wet) or dry material. The preparation of the pure material is difficult and firms do not reveal their techniques. In typical process insoluble alginate salts in the seaweed may be converted with alkali to sodium alginate, which is readily soluble in water. Further dilution of the mixture with fresh water causes the algal cell structure to break down and release the sodium alginate into solution.

Insoluble seaweed particles are then separated from the sodium alginate solution by standard solid-liquid clarification techniques such as centrifugation. Alginate is then recovered from the clarified sodium alginate solution by various techniques including precipitation with calcium chloride or sulfuric acid, electrolysis, or direct drying. Alginic acid is subsequently neutralized with appropriate bases, then dried and milled to produce the final product.

The Formula Known as Alginate

Sodium alginate, potassium alginate, or triethanolamine alginate is the main ingredient in the irreversible hydrocolloid impression materials known as alginate – the dental and prosthetic grade molding material. Categorized according to its different physico-chemical properties as gelling alginates, various mix ratios create impression materials with different qualities.

Commercial dental alginate impression materials formulas differ. With differing formulas come individual characteristics. Tear strength, slump rate, shrink rate, gel rate, flexibility and toughness vary according to ingredients. A typical formula contains a filler, such as diatomaceous earth, to increase rigidity and facilitate mixing, a reaction retarder, such as tetrasodium pyrophosphate, and pH-modifiers, such as magnesium oxide (base) and potassium fluortitanate (acidic), which act as setting aids.

Harvesting Kelp off the coast of California.

Diatomaceous earth (DE) consists of the sedimentary deposits formed from the skeletal remains of a class of algae of diatoms (Bacdlariophyceae) that occur in both salt and fresh water and in soil. These remains form *diatomite*, almost pure silica that is ground into an abrasive dust. It is primarily silicon dioxide (glass, sand) and is also used to stabilize nitroglycerine (Nobel's dynamite).

In most formulations, alginate is a minor ingredient of about 15-percent. A typical formula contains a sodium or potassium alginate (such as Protanal SF 120 RB) at a level of approximately 15%, a calcium source used as a reaction retarder at a use level of approximately 8% (such as tetrasodium pyrophosphate) pH modifiers (such as magnesium oxide--basic or potassium fluortitanate-acidic) at 0.5%-1%, and a filler such as diatomaceous earth, 75 percent for stability.

For the scientific artists the following reaction steps lead to the gelation:

A: $CaSO_4 \times 2H_2O$ (s) --> Ca^{2+} (aq) + SO_4^{2-} (aq)
B: NaAlg (s) --> Na^+ (aq) + Alg^- (aq)
C: $Na_4P_2O_7$ (s) --> 4 Na^+ (aq) + $P_2O_7^{4-}$ (aq)
D: 2 Ca^{2+} (aq) + $P_2O_7^{4-}$ (aq) --> $Ca_2P_2O_7$ (s)
E: Ca^{2+} (aq) + Alg^- (aq) --> $CaAlg^-$ gel

Formulas for lifecasting vary greatly. Typically, alginate used by lifecasting artists and mold makers is manufactured to a dental grade specification. This usually means that set times are fast – often too fast to create satisfactory molds of large areas. Some manufactures, are now making formulations especially for lifecasting and special effects work. These brands include the MoldGel line from Artmolds, the Accucast line, and Prosthetic Grade Cream. All three offer an excellent slower setting formula ideal for lifecasts.

Use in Lifecasting Art

Because of its history of safety in its use as a dental impression material as a prosthetic limb mold making material, alginate was discovered to be the ideal choice for artists and sculptors who desired to make molds directly from the human body. Prior to the use of alginate, molds were often made using plaster – sometimes causing injuries due that heat generated during setting. But alginate, a water based material, was completely safe and found to be comfortable in the process.

Alginate Characteristics

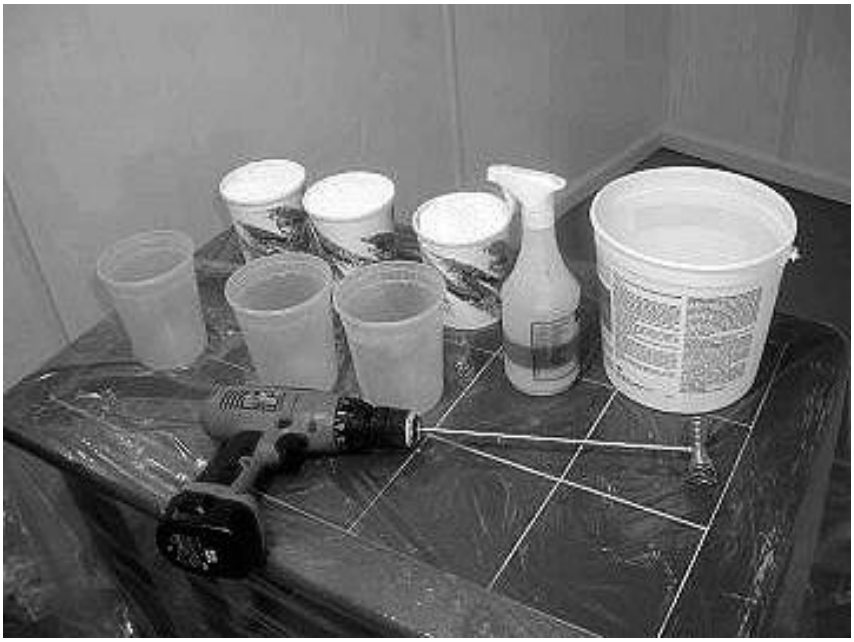
One of the interesting characteristics of alginate is that is does not adhere to itself once set. That same characteristic is however helpful in lifecast mold making, as alginate, like Teflon doesn't stick to anything (except the stainless steal of a JiffyMixer). However, alginate can be made to stick to itself by increasing the ph of its surface. This is readily accomplished by a painting on a mixture of baking soda diluted in water. Once accomplished another coat of alginate can be easily applied over the other.

Set time can often be adjusted by varying water temperature and mix ratios. The warmer the water and or the thicker the mixture -- the faster the set time. The opposite is true for slowing the set time. However, since lifecasting is the practicing of applying alginate to the skin of a live person, cold alginate creates both goose pumps and discomfort for the model. Newer formulations have been developed specifically for lifecasting that allows both for a set time up to 9 minutes and a water temperature approaching that of body temperature.

Ideal proportions of water-to-alginate vary from manufacturer to manufacturer, and with personal preference. The proportions a manufacturer suggests represent what they feel yields the optimum working consistency. However, we would suggest that in order to determine what proportions will produce the right consistency the artist should experiment with it.

Casting Wax into Alginate Molds.

Wax can be poured into alginate molds. The wax should be at 190 degrees for the first pour. First pour your 190-degree wax into a large container. Then fill the mold with 190-degree wax and dump it back into the container. Place a small fan so that it blows into the mold to cool the wax. You don't want it to get cold just cool. When the wax in your container drops to 180 degrees make your second pour into the mold and repeat fan cooling.



A lifecaster's setup preparing alginate for mold making. The three containers in the rear hold alginate powder. The large bucket on the right holds the water. The empty containers in the front will be used to combine the alginate and water.

Once again dump wax out of mold back into container. When the wax in the container cools to 170 degrees make the third and final pour. This should give you a mold thickness of 1/4 inch. You may have to adjust time and temperature slightly if you are using victory brown, different waxes chill or get thick at different temperatures. You may have to make the last pour at 175 degrees if the wax is too thick at 170.

Its Weaknesses as A Mold Making Material

With every benefit to a product or service one can find a weakness. Alginate does have a few. It cannot be used to make multiple castings for several reasons. It is not strong enough to resist tearing when demolding. The mold starts to shrink soon after it sets losing detail in a few hours and losing up to a third of its size in twenty four hours.

Though placing the mold in a plastic bag with a damp sponge can often extend casting time or actually freezing the mold, an alginate mold must be cast within an hour or two after the mold is made. One is also limited to the type material that may be cast into an alginate mold. Most any casting material with a water base is fine. However, materials that generate significant heat while setting such as resins and polyurethanes will cause the water in the alginate mold to turn to steam damaging the mold and the cast.

Comparing Alginates

The first thing we have to acknowledge is that we can only compare things of similar magnitude (i.e.; apples to apples). In the case of 'alginates', they are definitely not all created equal. Sodium alginate is by far the single most expensive part of the compound lifecasters call 'alginates'. As any experienced lifecaster knows, standard 'dental impression material' is far weaker than the 'prosthetic grade' versions. What's the difference? Primarily (this is a simplification), the concentration of this expensive sodium alginate in relation to the other, much less expensive ingredients.

The largest component of alginate is the water we add to form the fluid mix that can be applied to the body. Standard dental impression material can be made to perform as well as prosthetic grade if you simply add less water. Doing that gives us less overall volume of working medium, thereby raising the cost per unit of measure. This of course creates other complications such as a faster setting time and less tear strength. The point is that the entire subject is about ratios how much of one ingredient in relation to another.

Which returns us to the subject of comparison. The most common comparison measure is price.

An impression material that contains only 5% of sodium alginate, for example can be sold for much less than one that contains 10%, all other things being equal. The difference is only noticeable when used by an experienced lifecaster.

you in your comparison we have included a table of some of the better-known lifecasting alginate. Many different brands are available; consistencies, setting times, durability, and the like differ (See Table for a few examples).

"Particular brands are for the most part simply a matter of personal choice since most are pretty much interchangeable. However, most alginates have the same characteristic in that they exist in either a liquid or a solid state with a very short transition

Brand	Working Time	Mix Ratio Alginate to Water Regular	Thick	Water Temp	Amt. in Pounds	Cost Per lb.	Source
Accucast 390	3 min	1 to 3.2	1 to 2.7	90° F 32		$13.00	fxWarehouse
Accucast LS680 (Low shrink)	6 min	1 to 4	1 to 3.5	80° F 26		$13.00	fxWarehouse
Accucast 880 Imperial Gel	8 min	1 to 3.5	1 to 3	80° F 26	1 2 ½ 10 20	$12.95 12.20 8.50 8.25	fxWarehouse
Algiform Regular Set	2 ¼ min	2 to 3	1 to 1	Cold		$9.56	Pink House
Algiform Slow Set	7-8 min	2 to 3	1 to 1	70° F 21°C	1 ¼ 11 22	$10.36 8.09 7.04	Pink House
Bosworth - SuperGel	1 min	2 to 1		70° - 75°F \ 21° - 23°	1	$8.99	
Bosworth - Regular	2-3 min	2 to 1		70° - 75°F \ 21° - 23°			
Hydrogel - N	5-6 min	1 to 3			1	$9.99	Polytek
Gourmet Alginate	3-5 min	1 to 2		77° F	1	$8.36	GE Plastics
Coe							
MoldGel Regular Set Alginate	3-5 min	1 to 3	1 to 2.75	70° / 21°C	1	$7.95	ArtMolds.com
MoldGel SloSet Alginate	7-8 min	1 to 3	1 to 2.75	80° / 26°C	1 10 25	$8.25 7.50 6.75	ArtMolds.com

When mixed with equal amounts of water, one will be much thinner and weaker than the other. The less expensive one will not hold up as well in the mother mold, it will not capture as great a detail, it will shrink and crack faster, it will ooze water out faster (this is called syneresis) and not produce as high a quality castings nor as many from a single mold. In other words, you often get what you pay for.

Having said that though, not all manufacturers have the same overhead burdens. Some can offer mediums with high algin concentrations at the same price as others with low concentrations. Manufacturers all jealously guard their formulations but the only thing that should matter to a lifecaster is performance.

Check around, do the math, try different brands. To be fair to all manufacturers you simply cannot lump all impression materials into the 'alginates' category and compare simply by price per pound. Your conclusions will incorrect. To assist

Personal Experience by a Master Lifecaster

Dave Parvin, fine art sculptor, lifecasting teacher and frequent contributor to the *Art Casting Journal* describes his experiences.

"Years ago I developed a solution that I have used with great success and taught in all my workshops. – I felt then it was perfectly adequate. I would apply a layer of alginate that was just the right consistency and temperature to stay in place and be comfortable, and allow enough time for a flawless second layer of alginate into which I would embed the fuzzy material. The trick is to paint over the first layer with a mild base such as a solution of baking soda and water without which the alginate layers would not bond together. With this technique, I have been able to do far more complicated castings than would be otherwise possible. The only down side was the extra time and cost required for the second layer of alginate."

stage. For simple casts such as hands or face without the hair, ears, and shoulders, this poses no problem. "

"But as one progresses to more complicated castings, it becomes very difficult to apply the alginate and embed a layer of fuzzy material into alginate to hold a plaster shell mold fast before it sets-up. While either increasing the ratio of water to alginate or lowering the temperature of the water can extend setting time, neither of these solutions is adequate. Too runny and the alginate will not stay in place and too cold is not comfortable for the subject."

"There is however, another solution. MoldGel Sloset from ArtMolds Sculpture Studio is uniquely different from any other alginate I am aware of in three ways. The first is that it has the slowest setting time of any alginate that I have tried, 8 to 9 minutes even in very warm water. Secondly, it is more thixotropic (i.e. it stays in place without running off the model). Thirdly, the transition from a

liquid to a solid is far more gradual. The result is that one can apply an adequately thick layer that stays in place even in undercuts such as below ears, breasts, chins, etc. and ion small pointy places such as noses, nipples, finger tips, etc. This eliminates, for the most part, the need to keep applying additional alginate to hard to cover areas. The time saved along with a slower setting time allows the caster to apply the fuzz before the alginate gels. In addition, the more gradual gelling further prevents runoffs and indicates to the caster how much time is remaining. Eliminating the second layer of alginate reduces the overall time required for the process making it easier on the model. Because there is less runoff, less is wasted and the need for a second layer is eliminated. Combined with MoldGel's lower price than other brands, one's alginate cost is reduced by as much as 50%! For the above reasons, MoldGel SloSet is my first choice for anything except infant's hands."

Now that you know all about alginate, it is advisable that the lifecasting artist experiment with a variety of brands. Each brand will provide unique characteristics. No matter which brand one settles on, one can count on a product that will provide excellent reproduction and the certainty of safety with their model. **ACJ**