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3,657,181

ACOUSTICALLY TRANSPARENT COMPOSITION COMPRISING A THERMOPLASTIC POLYMER AND ORGANIC FLUORINE CONTAINING COM- POUND

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ABSTRACT OF THE DISCLOSURE

A material having acoustic transparency useful as a sonar window or lens comprising a homogeneous mixture of a thermoplastic material and an organic fluorine-containing material. The thermoplastic material has a density not greater than 1.5 and a sound transmission velocity not greater than 2.0×10^5 centimeters per second, but greater than the velocity of sound in water. The organic fluorine-containing material has a density greater than about 1.5 and a velocity of sound transmission less than water. The fluorine-containing material contains not more than 65% by weight of fluorine.

The product and process of this invention relate to an improved sonar window or lens. The window or lens has improved sound transmission characteristics relative to water.

The acoustically transparent device of this invention is comprised of a thermoplastic component having a density not greater than 1.5 and a sound transmission velocity not greater than 2.0×10^5 centimeters per second. The sound transmission velocity must, however, be greater than the velocity of sound in water. The other component of this acoustically transparent device is an organic fluorine-containing material having a density greater than about 1.5 and a velocity of sound transmission less than that of water. The fluorine-containing compound should have less than 65% by weight of fluorine.

The acoustically transparent device of this invention may also have a third component which acts as a density depressant. The term and the purpose of the third component will be explained subsequently.

An acoustically transparent material, either in the form of a window or a lens, is one capable of having sound waves pass through it to a receiving transducer positioned on the opposite side of the material from which the sound waves are generated.

When a sonar device is made, it is designed to measure the distance and location of objects within the water by measuring the time it takes for sound to be sent to and reflected back from an object in the water to a receiver which is a part of or located near to the sending device. The sender and receiver are transducers, i.e. devices which convert electrical energy to sound waves upon sending and reconvert to electrical energy when the reflected sound waves are received. Of course, the transducers must be shielded from the corrosive action of the sea water. The materials used for such protection must have the same acoustical properties as the water or else the calculations based on the acoustic properties of water will be distorted.

The terms "sonar window" and "sonar lens" refer to their acoustical relationship to water. In order to have a perfect sonar window, the velocity of sound through the window (hereinafter velocity will refer to the velocity of sound within a material) and the impedance must be identical to that of water. A sonar window is, therefore, a perfect acoustic match with water. In order to have a

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sonar lens, only the impedance of the lens must equal the impedance of water. Impedance is derived by multiplying the value for velocity by the density.

While there have been many attempts in the past to make a sonar window and many claims for the manufacture of a sonar window, no one has been able to design a system which matches both the velocity and the impedance of water. Most of the best materials tried, are in effect, sonar lenses. In other words, the impedance may be a match or nearly a match with water, but the velocity of sound through the particular material is not a match with water. The singular advantage of this invention is that the acoustical properties of the thermoplastic component may be varied at the will of the practitioner to provide the appropriate velocity and density to give an identical impedance, velocity and density value with water.

One of the problems of the conventional approaches of choosing a single material for an acoustical device is that the sound transmission characteristics of water are not constant. Solutes affect both velocity and density. For example, at 20° C. the density of sea water is 1.025 gm./cc. and the velocity is 1,560 meters per second. At 20° C. the density of fresh water is 1.0 gm./cc. and the velocity is 1,470 meters per second. Pressure on the water also affects velocity and density. Because the properties of the product of this invention can be varied to meet specific velocity and density conditions, separate windows can be manufactured with acoustical compatibility with fresh water or with acoustical compatibility with sea water, or with acoustical compatibility for fresh or sea water at various depths.

While there have been several previous prior art attempts to devise a satisfactory window, the problem with these attempts is that they produce materials which may be useful for one specific set of conditions but may be unsatisfactory for the particular conditions of application and use. For example, when sea water temperature changes from 5° C. to 15° C., the velocity of sound changes from 1.510×10^5 cm./sec. to 1.602×10^5 cm./sec. Therefore, a sonar device which claims to contain a sonar window with a velocity of, say, 1.57×10^5 cm./sec. would provide an identical match at a water temperature of 25° C. However, if this window was placed on a submarine, as the submarine submerged and the water temperature decreased to, say, 5° C. there would be a difference of 6,000 centimeters per second in the velocity of sound through the cooler water. The main import of this fact is that a "window" under one condition would not be a "window" under different conditions of velocity and density. If it is desired, therefore, to design a sonar window which can be used on a submarine, the conditions under which the submarine conventionally operates should be the conditions for which the sonar window is designed. The same window, if applied to a surface craft, would not be a window at the conditions of decreased depth. Also, a window for salt water would not be a window for fresh water due to the difference in density even if their velocities were equal. The ideal, therefore, would be to be able to alter the acoustical properties of the particular compound chosen as the base component for the sonar window to be able to make a "window" suited specifically for the conditions of operation. (The expression "environment of use" will be used to indicate a desired set of values for velocity and density for the window or lens as dictated by the velocity and density values of the particular aqueous environment in which the sonar device will be used.) Previous attempts have been directed to using a specific material which falls within a desired range of values for velocity, density and impedance. Now, according to the teachings of this invention, it is possible to choose a set of operating conditions and provide a win-

dow which is satisfactory for such conditions. It is not believed that this approach has previously been used to accomplish this desideratum. With the teachings of this invention, the ultimate in sonar transparencies may be obtained.

The acoustically transparent material of this invention is comprised of a thermoplastic component, an organic fluorine-containing component and optionally, a density depressant. The advantages in using a thermoplastic for a window or lens are inherent in the nature of the thermoplastics, e.g. ease of shaping, corrosion resistance, extrudability, water insolubility. Various rubbers are commonly used, but the disadvantages in handling, e.g. the need for vulcanization and the susceptibility to light decomposition indicate that rubber is not a panacea for a sonar transparency. Under certain conditions of temperature and pressure the natural rubbers are close to an impedance match with water, but natural rubbers have poor resistance to oils, sunlight, and abrasion.

For the thermoplastic to be useful, it must have a velocity less than about 2,000 meters per second. If the velocity is greater than 2,000 meters per second, it is not generally possible to depress the velocity to the appropriate level. This problem is magnified if the sonar window is designed to be rigid. It is possible that the fluorine-containing compound may act as a plasticizer for the thermoplastic; and if sufficient fluorine-containing compound is used to alter a thermoplastic with a velocity greater than 2,000 meters per second to the desired velocity, the thermoplastic may lose its desired structural properties. If, however, the material is used to make a flexible window, the problem is not as acute and thermoplastics having a velocity slightly above 2,000 meters per second may be used. This may also be the case if the fluorine-containing compound is not a plasticizer. Generally, it is preferred that the mixture be comprised primarily of the thermoplastic, i.e. the thermoplastic should be greater than 56% by weight of the window. It is possible that the particular thermoplastic used can have some cross-linking present in its final form. A plastic which is completely thermoset, i.e. highly cross-linked, is not useful within the teachings of this invention because the fluorine-containing component cannot be retained in solution in the cross-linked structure. Small levels of cross-linking are, however, tolerable.

While the use of thermoplastics in a sonar device is not new per se, there have been problems when thermoplastics were used for that purpose. In Patent No. 2,434,666, issued Jan. 20, 1948, a series of thermoplastic materials are disclosed for the purpose of making a sonar window. The preferred plastics disclosed are cellulose acetate butyrate and polyesters which are supposed to give the closest match with water. It is apparent that these materials are only useful for specific conditions of temperature and pressure and produce velocity and impedance values which are by no means the same as any environment of use. This invention, however, provides means for utilizing a large variety of thermoplastics to provide the desired acoustical conditions for any particular set of acoustical conditions as indicated above.

The second component of the product of this invention is an organic fluorine-containing compound. While some perfluoro compounds have been studied in relation to their acoustical properties and found to have extremely low sound velocity transmission characteristics, they have been regarded more or less in the past as curiosity pieces. The reason for this is that the perfluoro compounds tested were not compatible with, i.e. soluble in the water-insoluble materials necessary for the manufacture of a sonar window. It has now been found that certain compounds containing fluorine are soluble in thermoplastics and also have low velocity. Materials containing no more than about 65% fluorine are sufficiently soluble in and compatible with the thermoplastics of this invention. The amount of fluorine-containing compound needed will, of course,

vary with the acoustical properties of the thermoplastic.

The utilization of a third component, if one is needed, will be based on the composite acoustic properties of the fluorine-containing compound and the thermoplastic and the compatibility with the fluorine-containing materials to form a homogeneous system. Solubility is dependent in part upon the functional groups of the organic fluorine-containing compound. If the functional groups enhance the solubility with the thermoplastic, then a fluorine component having a low sound velocity, i.e. high fluorine content, and relatively high solubility, may be utilized. Organic fluorine-containing compounds containing more than 65% fluorine have proven to be not sufficiently soluble in the class of thermoplastics referred to above to be useful within the teachings of this invention. Of course, the lower the velocity of the thermoplastic material the smaller the amount of fluorocarbon need be added. It is also possible when using a thermoplastic material with the velocity near the desired velocity of water to use a relatively high velocity organic fluorine compound to achieve the same effect. The choice of the fluorine compound and the amount of the fluorine compound used is, therefore, obviously dependent upon the thermoplastic desired for use in the sonar window.

The preferred class of compounds are those containing a fluoroaliphatic moiety. By fluoroaliphatic it is meant that the hydrogens on the carbon are substituted with fluorine. The structure of the moiety may be cyclic, linear, or branched and may contain trivalent nitrogen or divalent oxygen as a replacement for one or more carbons in the backbone of the moiety. It is especially preferred that most of the fluorine in the fluoroaliphatic moiety be present in perfluoro groups. By localizing the situs of the fluorine, its effectiveness as a velocity depressant is heightened. In other words, the presence of perfluoro groups produce a compound with a lower velocity than a similar compound with the same molecular weight and fluorine content. While this localized situs of fluorine will tend to diminish its solubility in thermoplastics, the increased effect on velocity will minimize the amount of the fluorine-containing component needed. Amounts sufficient to produce the desired effect may still be added as long as the total fluorine content is less than about 65% by weight.

It is recommended when practicing the teachings of this invention to choose the thermoplastic material first and then to select a fluorine-containing compound having the required acoustical and solubility characteristics to alter the characteristics of the thermoplastic material. The choice of thermoplastic is dependent upon a large variety of obvious factors, such as cost, insolubility in sea water, chemical stability, ease of handling, etc.

The solubility in thermoplastics of these compounds is dependent on a number of factors including the amount of fluorine present and its location within the compound, the molecular weight of the compounds, whether and to what extent they are polymerized and the regularity of structure. Compounds which have a relatively high molecular weight are generally less soluble than compounds of a similar type of lower molecular weight. High molecular weight polymers which are derived from compounds with minimal amounts of side chains tend toward crystallinity. Crystalline compounds are more highly insoluble than amorphous compounds of like molecular weight and also have a higher velocity. Generally, for amorphous compounds a molecular weight of 20,000 is a practical maximum for the fluorine-containing compounds of this invention. For compounds which tend toward crystallinity, the maximum molecular weight would be somewhat lower. For example, polychlorotrifluoroethylene polymers of relatively low molecular weight, such as the Kel-F oils manufactured by Minnesota Mining and Manufacturing Company, will function within the teachings of this invention but crystallizable high molecular weight polymers will not be useful. Polymers of this material up to a

molecular weight of no more than about 15,000 will function according to the teachings of this invention.

Another preferred class of fluorine compounds are the perfluoroalkyl aromatic compounds, such as perfluoroheptyl benzene (64% F) which is an example of a fluorine-containing compound, which performs according to the teachings of this invention. Other typical compounds which will work but may limit the choice of a density depressant to some extent are

- (1) $C_8F_{17}SO_2N(C_3H_7)CH_2CH_2OCOCH=CH_2$,
- (2) $C_8F_{17}SO_2N(CH_3)C_{11}H_{22}OCOCH=CH_2$,
- (3) $C_8F_{17}SO_2NHC_2H_5$, and
- (4) $C_8F_{17}SO_2N(C_4H_9)C_2H_4OH$

The table below lists some of the compatible density depressants for use with these compounds, and their acoustical properties.

TABLE I

Compound Number:	Acoustical properties		Solubility		
	Velocity, m./sec.	Density, gm./cc.	Mineral oil	n-Dioctyl ether	n-Butyl stearate
1.....	935	1.5	No.....	Yes.....	Hot, yes.
2.....	1,345	1.5	Hot, yes; cold, sl.	Yes.....	Yes.
3.....	910	1.64	No.....	No.....	Yes.
4.....	950	1.64	Hot, yes.....	No.....	Hot, yes.
Polychlorotrifluoroethylene oil, mol. wt. 630 (Kel-F #3).....	890	1.94	Yes.....	Yes.....	Yes.
Perfluoroheptyl benzene.....	795	1.64	Stable dispersion, no solubility.	Yes.....	Yes.

It is also preferred that the level of fluorine in the compound be greater than 30% and most preferably greater than about 45% for the fluorine to be effective to sufficiently depress the velocity of the thermoplastic chosen.

The optional third component of the acoustical material of this invention is a density depressant. The fluorine-containing compound is a compound of a relatively high density, i.e. greater than about 1.5. This is due to the presence of the fluorine or other halogen. The density of the thermoplastic materials varies but is generally between 0.9 and 1.5. If a thermoplastic with a relatively high density is used in conjunction with a high density fluorine-containing compound in accordance with the teachings of this invention, then a density depressant which is compatible with the two components must be used to form a sonar window. The use of a density depressant may also be necessary when large amounts of fluorine-containing compound are required to provide a velocity match. In this case, the utilization of these compounds would counter-balance the relatively high density of the fluorine-containing compounds. The density depressant compounds should have a density less than sea water (if the window is a sea water window) and preferably less than 1.0 gm./cc. at 20° C. The density depressant must be mutually soluble with the fluorine-containing compound and the thermoplastic and water insoluble. Such widely diverse materials as mineral oil and butyl stearate, linear poly(vinyl alcohol), ethers and esters and almost any compatible liquid having the appropriate density characteristics of low volatility under the conditions of manufacture of the window and solubility will function as a density depressant. Generally, moderately polar nonionic halogen-free, oxygen-containing organic liquids boiling above about 250° C. are preferred. Such materials tend to be soluble in both primary components and may also improve solubility of the fluorine-containing compound in the thermoplastic.

The amount of density depressant used will, of course, be dependent upon the other materials chosen. While it may not be necessary to use density depressants, this class of compounds enables the use of a much wider variety of thermoplastics and fluorine-containing compounds.

All of the disclosure applicable to the designing of a window is also applicable to the designing of a lens. A lens with the proper characteristics may add directionality to a sonar unit or other desirable characteristics by allowing focusing of the sound beam. For the above reasons, the idea of being able to design a special lens is as functional as the idea of being able to vary acoustical properties specifically for the manufacture of a window.

The lens or window of this invention must be homogeneous, that is, must consist of a single phase with no internal reflection. If the product exists as a multi-phase system, the beam is attenuated due to increased internal reflection. In order to achieve this homogeneity, the components must be mutually soluble to the extent they are needed to form a single phase system.

Examples of the product of this invention follow. These examples are designed to illustrate the broad con-

cept embodied within the teachings of this invention and are not designed to be anything other than illustrative of the scope of the disclosure embodied herein.

Velocity determinations for the examples were made by placing the sample between two transducers (Probe Sonic PF-101-50 made by Channel Industries) with the transducers abutting the sample. The time required for a pulsed signal to pass through the sample was determined from the single image as shown in an oscilloscope (Teletronics 5 61A with 3Ab dual trace amplifier and 3B4 time base.) The formula for calculating velocity is

$$V = \frac{\text{Distance}}{\text{Time}}$$

All of the velocity measurements were taken at 22° C.

These examples are designed to illustrate specific velocity and impedance within the range of acceptable values for a sonar window or lens. Sea water at atmospheric pressure varies in velocity from 1.510×10^5 cm./sec. to 1.570×10^5 cm./sec. when the temperature changes from 5° C. to 25° C. Distilled water velocity varies from 1.426×10^5 to 1.478×10^5 cm./sec. as temperature changes from 5° C. to 20° C.

EXAMPLE 1

This example illustrates the manufacture of a material having acoustic transparency for one set of environmental conditions. The ingredients used to make the low attenuation transducer of this example and the corresponding acoustical properties are indicated below.

Material	Vol. percent	V (cm./sec.)	D (gm./cc.)	Impedance
Elyax 210.....	79.6	1.55×10^5	0.95	1.475×10^5
Mineral oil.....	13.9	1.34×10^5	0.83	1.120×10^5
Halo Carbon Oil #13-21.....	6.5	8.7×10^4	1.95	1.695×10^5
Product window.....	100	1.45×10^5	1.0	1.45×10^5

Elyax 210 is a trademark of DuPont and is an ethylene-vinyl acetate copolymer; Halo Carbon Oil #13-21 is a liquid polychlorotrifluoro ethylene polymer sold by Halo Carbon Products Corp. having a molecular weight of about 800.

The three components were mixed at 280° F. until completely homogeneous and then poured into a mold.

The temperature was maintained until all of the bubbles had evolved. The window was then allowed to cool at room temperature. After cooling, the fresh water window was ready for use.

EXAMPLE 2

This example illustrates the use of a two-component system to make a window for another environment of use. Velocity of sound in water increases as temperature increases and density decreases, therefore, as mentioned above, alterability of acoustic values for a specific set of conditions is essential. The ingredients used are indicated in the table below:

Material	Vol. percent	V (cm./sec.)	D (gm./cc.)	Impedance
Elvax 210.....	95	1.55×10^5	0.95	1.475×10^5
Halo Carbon Oil #13-21...	5	8.7×10^4	1.95	1.695×10^5
Window.....	100	1.52×10^5	1.0	1.520×10^5

The sonar window was prepared as follows. Elvax was heated to 280° F. until molten. The oil was then added. The mixture was agitated until completely homogeneous and then poured into a mold. Temperature was maintained at 280° F. until all bubbles had evolved and the mixture was then allowed to cool at room temperature.

EXAMPLE 3

This example illustrates percent of sound transmission through the windows of Examples 1 and 2. This example also illustrates the minimal amounts of reflection of sound waves when the product of this invention is utilized.

Two Ray Jefferson Depthometer 500 Transducers using approximately 200 kHz. resonant frequency and a 0.75 cm. wave length were mounted on a vertical track which was placed in a water tank. The sending transducer assembly was submerged in the water with its face perpendicular to the surface. The receiving transducer was attached to the window holder assembly which was also

sending transducer and the amount of signal received at the receiving transducer indicates the percent transmission.

Reflectance was determined by adjusting to full scale the signal voltage reflected back to the active transducer (which is also a receiving transducer) from an essentially completely reflective stainless steel sample. The reference reflector was then replaced by the samples to be tested with the percentage of the signal voltage of the samples relative to that of the reference signal being used as a measure of reflectance.

The samples produced the results as indicated below:

Example Number	Thickness, cm.	Percent	
		Reflection	Transmission
1.....	1.2	1	93
2.....	1.7	4	88

The percentage of the signal which is neither reflected nor transmitted is attenuated, i.e. absorbed and dispersed within the window itself. (Of course, thickness also affects percent transmission.)

EXAMPLES 4-12

These examples illustrates some of the wide variety of density depressant materials and thermoplastics which may be used to practice the teachings of this invention. Measurements were taken from the table below according to the procedures outlined in Examples 1-3 and molded as outlined in Examples 1-3 and molded as outlined in Example 1. The thermoplastics used in these examples are as follows.

Kraton 125-1000-5 is a 70:30 butadiene-styrene block copolymer made by Shell Oil; Zetafax 1370 is a 70:30 ethylene:isobutylacrylate copolymer; and Zetafax 1278 is an 80:20 ethylene:ethylacrylate copolymer. Zetafax is a trademark of Dow Chemical Co.

TABLE II

	Velocity	Density	Percent vol.	Example	Composite		Impedance	Percent	
					Density, gm./cc.	Velocity, cm./sec.		Transmission	Reflection
Kraton 125-1000-5.....	1,565	0.94	88.9	4	0.98	1.46×10^5	1.43×10^5	93	2
White Oil #5.....	1,330	0.83	3.2						
Kel-F #3.....	880	1.94	7.9						
Kraton 125-1000-5.....	1,565	0.94	88.4	5	1.1	1.455×10^5	1.47×10^5	95	4
Dioctyl ether.....	1,320	0.805	2.8						
Kel-F #3.....	880	1.94	8.8						
Kraton 125-1000-5.....	1,565	0.94	83.6	6	1.02	1.42×10^5	1.45×10^5	97	1
n-Butyl stearate.....	1,310	.85	2.2						
Kel-F #3.....	880	1.94	14.2						
Elvax 210.....	1,550	0.95	79.6	7	1.0	1.45×10^5	1.45×10^5	93	1
White Oil #5.....	1,330	0.83	13.9						
Kel-F #3.....	880	1.94	6.5						
Elvax 210.....	1,550	0.95	88.5	8	1.02	1.42×10^5	1.45×10^5	82	5
Dioctyl ether.....	1,320	0.805	3.3						
Kel-F #3.....	880	1.94	8.2						
Elvax 210.....	1,550	0.95	90.0	9	1.01	1.45×10^5	1.47×10^5	88	4
n-Butyl stearate.....	1,310	0.85	2.5						
Kel-F #3.....	880	1.94	7.5						
Zetafax 1370.....	1,765	0.895	83.1	10	1.06	1.4×10^5	1.485×10^5	90	1
White Oil #5.....	1,330	0.83	4.9						
Kel-F #3.....	880	1.94	12.0						
Zetafax 1278.....	1,665	0.90	79.2	11	1.026	1.42×10^5	1.46×10^5	82	14
Dioctyl ether.....	1,320	0.805	7.8						
Kel-F #3.....	880	1.94	13.0						
Zetafax 1278.....	1,665	0.90	78.8	12	1.03	1.435×10^5	1.48×10^5	88	4
n-Butyl stearate.....	1,310	0.85	8.9						
Kel-F #3.....	880	1.94	12.3						

mounted on the track and adjusted to be parallel to the window to be tested. The sending transducer was 71.1 cm. from the receiving transducer. Using the tank water as a control, a 100% transmission reference signal was established by adjusting the signal voltage received by the receiving transducer to full scale on the oscilloscope. With the transducers and the inserted sample aligned parallel to one another, the signal voltage was again sent by the

EXAMPLE 13

This example illustrates the utilization of perfluoroheptylbenzene in accordance with the teachings of this invention. The procedures for making the material and testing its properties are as indicated in the preceding examples. The table below illustrates the acoustical properties of the individual components and the window.

Ingredient	Percent vol.	V (m./sec.)	D (gm./cc.)
Perfluoroheptyl benzene.....	10.4	795	1.55
Elvax 210.....	89.6	1,550	0.95
Window.....	100	1,460	1.0

EXAMPLE 14

This example illustrates yet another preferred fluoro-alkyl compound, 1-perfluorooctyl octane. This compound has the formula $C_8F_{17}(CH_2)_7CH_3$. The method of manufacture and the method of measurement is the same as that used in the prior examples. The table below indicates the ingredients and the acoustical properties of the lens.

Ingredient	Gms.	V (m./sec.)	D (gm./cc.)
Elvax 210.....	100	1.600×10^5	0.95
1-perfluorooctyl octane.....	13	8.460×10^4	1.8
Window.....	113	1.475×10^5	0.98

EXAMPLE 15

This example illustrates the effect of pressure on the material of this invention. The acoustic properties of windows and lenses vary with pressure as does the environment in which the material is used. The window was made and evaluated in the manner of the prior examples as illustrated in the table below:

Ingredient	Gms.	V (m./sec.)	D (gm./cc.)
Elvax 420.....	60.0	1,700	0.94
Dioctyl ether.....	21.5	1,430	0.80
Kel-F #3.....	18.5	875	1.94
Window.....	100		.99

When the window was solidified, it was subjected to pressure of 1,000 p.s.i. i.e. 2.765×10^4 gm./cc., 2,000 p.s.i. and 3,000 p.s.i. and the velocity was measured while the material was under pressure. The results were as follows:

Pressure p.s.i.	V (cm./sec.)
1,000	1.430×10^5
2,000	1.450×10^5
3,000	1.490×10^5

This example also illustrates the use of a relatively high velocity plastic. While if plastics of different velocities are equally advantageous from the standpoint of resistance to pressure, sunlight and chemicals, and water insolubility, cost and ease of handling, the lower velocity thermoplastic is preferred; higher velocity plastics are also useful.

What is claimed is:

1. A composition solid at room temperature and having acoustic transparency with respect to a body of water, and comprising a major portion of a water-insoluble organic polymeric thermoplastic resin having a density less than 1.5 grams/cc. and a sound transmission velocity between the sound transmission velocity of water and 2,000 m./sec., said resin being selected from the group consisting of copolymers of ethylene and copolymers of butadiene, a minor portion of water-insoluble organic fluorine-containing compound having a density greater than 1.5 grams/cc., a molecular weight less than 15,000

and a sound transmission velocity less than the sound transmission velocity of water, said fluorine-containing compound having a plurality of adjacent fluorinated carbon atoms including at least one perfluoro group and containing between about 30% and about 65% fluorine by weight, and from 0 to about 25% by weight of a compatible organic density depressant having a density less than that of water, said resin, said fluorine-containing compound, and said density depressant being mutually soluble, said components being selected and proportioned to provide upon mixing a composition having an acoustic impedance substantially that of said body of water.

2. A sonar window comprising the shaped composition of claim 1 wherein said components are selected and proportioned to provide upon mixing a composition having a density and a sound velocity transmission substantially that of water.

3. The composition of claim 1 wherein the thermoplastic resin is ethylene-vinyl acetate copolymer and the fluorine-containing compound is polychlorotrifluoroethylene.

4. The composition of claim 1 wherein the density depressant comprises mineral oil.

5. A method of making a composition which has acoustic transparency with respect to a body of water and comprising admixing a major portion of a water-insoluble organic polymeric thermoplastic resin having a density less than 1.5 grams/cc. and a sound transmission velocity between the sound transmission velocity of water and 2,000 m./sec., said resin being selected from the group consisting of copolymers of ethylene and copolymers of butadiene, a minor portion of a water-insoluble organic fluorine-containing compound having a density greater than 1.5 grams/cc., a molecular weight less than 15,000, and a sound transmission velocity less than the sound transmission velocity of water, said fluorine-containing compound having a plurality of adjacent fluorinated carbon atoms including at least one perfluoro group and containing between about 30% and about 65% fluorine by weight, and from 0 to about 25% by weight of a compatible organic density depressant having a density less than that of water, said resin, fluorine-containing compound, and density depressant being mutually soluble, said components being admixed in sufficient proportion to provide a homogeneous composition having acoustic impedance value substantially that of water.

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