contact. Even when a single layer of polyurethane insulation is applied, bondlines form when the reaction mixture divides into multiple flow fronts as it flows around the part and the separate flow fronts meet. When the polyurethane does not adhere to itself very strongly, cracks appear at the bondlines. This leads to a loss of thermal insulation efficiency and can expose the underlying substrate to the corrosive effects of seawater.

What is needed in the art is a method of making a syntactic polyurethane elastomer, which does not contain a mercury catalyst, which is resistant to cracking and which bonds well to itself.

This disclosure is in one embodiment a cured syntactic polyurethane elastomer in which gas filled microspheres are dispersed in a noncellular polyurethane matrix, which syntactic polyurethane elastomer is a reaction product of at least one polyether polyol having a number average hydroxyl equivalent weight of at least 800, 5 to 50 weight percent of microspheres based on the total weight of the reaction mixture, 1 to 30 parts by weight of a hydroxyl-terminated chain extender per 100 parts by weight of the polyether polyol(s), an aromatic polyisocyanate in amount to provide an isocyanate index of 80 to 130 and a non-mercury catalyst, wherein the reaction mixture is essentially devoid of mercury compounds and the noncellular polyurethane matrix has a phase-segregated morphology characterized by the presence of small discrete morphological domains 0.1 to 3 μm in diameter, and

the substantial absence of discrete morphological domains 5 to 30 μm in diameter.

It has been found that the morphology of the noncellular polyurethane matrix closely correlates to the properties of the syntactic polyurethane elastomer. The morphology of the syntactic polyurethane elastomer is similar to those made using conventional mercury catalysts, even though no mercury catalyst is present. Good tensile and elongation properties are seen with this disclosure, along with good resistance to cracking and good ability to form strong bonds to itself.

The elastomer of the disclosure is suitable as thermal insulation for a wide variety of substrates. Substrates of interest are parts that require thermal insulation. Subsea pipe and architecture are substrates of particular interest.

An important advantage of this disclosure is that the syntactic polyurethane elastomer adheres well to itself and to other cured polyurethane

elastomers. This is an especially important advantage when multiple sections of the syntactic polyurethane elastomer are applied to a substrate and in contact with each other, and good bonding between the sections is wanted. Thus, in certain embodiments, the disclosure is a coated substrate having multiple sections of an applied syntactic polyurethane elastomer in which gas filled microspheres are dispersed in a noncellular polyurethane matrix, the multiple sections being in contact with each other at one or more bondlines.

In one aspect, the present disclosure provides a coated undersea pipe or undersea architecture having multiple sections of an applied syntactic polyurethane elastomer in which gas filled microspheres are dispersed in a noncellular polyurethane matrix, the multiple sections being in contact with each other at one or more bondlines, comprising

a) a first section of a first syntactic polyurethane elastomer on at least a portion of the substrate which first section of syntactic polyurethane elastomer is a reaction product of a reaction mixture containing at least one polyether polyol having a number average hydroxyl equivalent weight of 1500 to 3000, 5 to 50 weight percent of microspheres based on the total weight of the reaction mixture, 5 to 25 parts by weight of a hydroxyl-terminated chain extender having a hydroxyl equivalent weight of up to 125 per 100 parts by weight of the polyether polyol(s), an aromatic polyisocyanate in amount to provide an isocyanate index of 80 to 130 and a non-mercury catalyst, wherein the reaction mixture is essentially devoid of mercury compounds, contains no more than 500 parts per million water and at most 5 parts by weight, per 100 parts by weight of the polyether polyol(s), of other isocyanate-reactive materials, and the noncellular polyurethane matrix of the first syntactic polyurethane elastomer has a morphology characterized by the presence of discrete morphological domains 0.1 to 3 μm in diameter, and the substantial absence of discrete morphological domains 5 to 30 μm in diameter and

b) a second section of a second syntactic polyurethane elastomer on at least a portion of the substrate which second section of syntactic polyurethane elastomer is a reaction product of a reaction mixture containing at least one polyether polyol having a number average hydroxyl equivalent weight of at least 1500 to 3000, 5 to 50 weight percent of microspheres based on the total weight of the reaction mixture, 5 to 25 parts by weight of a hydroxyl- terminated chain extender having a hydroxyl equivalent weight of up to 125 per 100 parts by weight of the polyether polyol(s), an aromatic polyisocyanate in amount to provide an isocyanate

index of 80 to 130 and a non-mercury catalyst, wherein the reaction mixture is essentially devoid of mercury compounds, contains no more than 500 parts per million water and at most 5 parts by weight, per 100 parts by weight of the polyether polyol(s), of other isocyanate-reactive materials, and the noncellular polyurethane matrix of the second syntactic polyurethane elastomer has a morphology characterized by the presence of discrete morphological domains 0.1 to 3 μm in diameter, and the substantial absence of discrete morphological domains 5 to 30 μm in diameter,

wherein said first section contacts said second section to form at least one bondline at which the first section is adhered to said second section.

Such a coated substrate has:

a) a first section of a first syntactic polyurethane elastomer on at least a portion of the substrate which first section of syntactic polyurethane elastomer is a reaction product of at least one polyether polyol having a number average hydroxyl equivalent weight of at least 800, 5 to 50 weight percent of microspheres based on the total weight of the reaction mixture, 1 to 30 parts by weight of a hydroxyl-terminated chain extender per 100 parts by weight of the polyether polyol(s), an aromatic polyisocyanate in amount to provide an isocyanate index of 80 to 130 and a non-mercury catalyst, wherein the reaction mixture is essentially devoid of organomercury compounds and the noncellular polyurethane matrix of the first syntactic polyurethane elastomer has a phase-segregated morphology characterized by the presence of small discrete morphological domains 0.1 to 3 μm in diameter, and the substantial absence of discrete morphological domains 5 to 30 μm in diameter and

b) a second section of a second syntactic polyurethane elastomer on at least a portion of the substrate which second section of syntactic polyurethane elastomer is a reaction product of at least one polyether polyol having a number average hydroxyl equivalent weight of at least 800, 5 to 50 weight percent of microspheres based on the total weight of the reaction mixture, 1 to 30 parts by weight of a hydroxyl-terminated chain extender per 100 parts by weight of the polyether polyol(s), an aromatic polyisocyanate in amount to provide an isocyanate index of 80 to 130 and a non-mercury catalyst, wherein the reaction mixture is essentially devoid of organomercury compounds and the noncellular polyurethane matrix of the second syntactic polyurethane elastomer has a phase segregated morphology characterized by the presence of small discrete morphological domains 0.1 to 3 μm in diameter, and the substantial absence of discrete morphological domains 5 to 30 μm in diameter,

WHAT IS CLAIMED IS:

1. A coated undersea pipe or undersea architecture having multiple sections of an applied syntactic polyurethane elastomer in which gas filled microspheres are dispersed in a noncellular polyurethane matrix, the multiple sections being in contact with each other at one or more bondlines, comprising

a) a first section of a first syntactic polyurethane elastomer on at least a portion of the substrate which first section of syntactic polyurethane elastomer is a reaction product of a reaction mixture containing at least one polyether polyol having a number average hydroxyl equivalent weight of 1500 to 3000, 5 to 50 weight percent of microspheres based on the total weight of the reaction mixture, 5 to 25 parts by weight of a hydroxyl-terminated chain extender having a hydroxyl equivalent weight of up to 125 per 100 parts by weight of the polyether polyol(s), an aromatic polyisocyanate in amount to provide an isocyanate index of 80 to 130 and a non-mercury catalyst, wherein the reaction mixture is essentially devoid of mercury compounds, contains no more than 500 parts per million water and at most 5 parts by weight, per 100 parts by weight of the polyether polyol(s), of other isocyanate-reactive materials, and the noncellular polyurethane matrix of the first syntactic polyurethane elastomer has a morphology characterized by the presence of discrete morphological domains 0.1 to 3 μm in diameter, and the substantial absence of discrete morphological domains 5 to 30 μm in diameter and

b) a second section of a second syntactic polyurethane elastomer on at least a portion of the substrate which second section of syntactic polyurethane elastomer is a reaction product of a reaction mixture containing at least one polyether polyol having a number average hydroxyl equivalent weight of

1500 to 3000, 5 to 50 weight percent of microspheres based on the total weight of the reaction mixture, 5 to 25 parts by weight of a hydroxyl-terminated chain extender having a hydroxyl equivalent weight of up to 125 per 100 parts by weight of the polyether polyol(s), an aromatic polyisocyanate in amount to provide an isocyanate index of 80 to 130 and a non-mercury catalyst, wherein the reaction mixture is essentially devoid of mercury compounds, contains no more than 500 parts per million water and at most 5 parts by weight, per 100 parts by weight of the polyether polyol(s), of other isocyanate-reactive materials, and the noncellular

polyurethane matrix of the second syntactic polyurethane elastomer has a morphology characterized by the presence of discrete morphological domains 0.1 to 3 μm in diameter, and the substantial absence of discrete morphological domains 5 to 30 μm in diameter,

wherein said first section contacts said second section to form at least one bondline at which the first section is adhered to said second section.

2. The coated undersea pipe or undersea architecture of claim 1 wherein each of the first and second sections of syntactic polyurethane elastomer exhibits on dynamic mechanical analysis a tan δ peak having a maximum value of 0.15 to 0.3 centered in the temperature range of 30 to 100°C.

3. The coated undersea pipe or undersea architecture of claim 2, wherein the tan δ curve for each of the first and second sections of syntactic polyurethane elastomer includes a local maximum in the range of -100°C to -30°C, a minimum centered at about -30°C to about 10°C, a minimum centered above 100°C and another local maximum at a temperature greater than 150°C.

4. The coated undersea pipe or undersea architecture of any of claims 1-3 wherein the non-mercury catalyst is a zinc carboxylate or a mixture of metal carboxylates of which mixture zinc carboxylates constitute at least 99.9% weight percent of the catalyst.

5. The coated undersea pipe or undersea architecture of claim 1 wherein the undersea pipe or undersea architecture is branched, curved or has another non-linear configuration.

6. The coated undersea pipe or undersea architecture of claim 1 wherein the undersea pipe or undersea architecture has one or

more external features that protrude partially or completely through the applied syntactic polyurethane elastomer.

7. The coated undersea pipe or undersea architecture of claim 4 wherein the reaction mixture further contains 0.05 to 1% by weight, based on the combined weight of all components of the reaction mixture except the polyisocyanate(s) of a β-diketone compound.

8. The coated undersea pipe or undersea architecture of claim 7 wherein the β-diketone compound is acetylacetone, hexane-2,4-dione, heptane-3,5-dione or 2,2,6,6-tetramethyl-3,5-heptanedione.