WHAT IS CLAIMED IS:

1. A method for making a syntactic polyurethane elastomer, comprising

a) forming a reaction mixture containing an alkylene glycol chain extender, 5 to 50 weight percent, based on the weight of the reaction mixture, of microspheres, an isocyanate-terminated prepolymer having an isocyanate content of 3 to 12% by weight, and a non-mercury catalyst, wherein (i) the prepolymer is the reaction product of at least one polyether polyol having a number average hydroxyl equivalent weight of at least 800 with an excess of an aromatic polyisocyanate, (ii) the amount of prepolymer provided to the reaction mixture is sufficient to provide an isocyanate index of 80 to 130, (iii) wherein the non-mercury catalyst is a zinc carboxylate or a mixture of 98-99.99 weight percent of one or more zinc carboxylates and 0.01 to 2 weight percent of one or more zirconium carboxylates and (~~iiii~~iv) the reaction mixture is essentially devoid of mercury compounds, and

b) curing the reaction mixture to form the syntactic polyurethane elastomer.

2. The process of claim 1 wherein in step b) is performed on the surface of a substrate to form a coating of the syntactic polyurethane elastomer on the substrate.

3. A process for producing a substrate having an applied syntactic polyurethane elastomer, comprising

a) forming a section of a syntactic polyurethane elastomer on at least a portion of the substrate by (1) applying a first reaction mixture containing an alkylene glycol chain extender, 5 to 35 weight percent, based on the weight of the reaction mixture, of microspheres, an isocyanate-terminated prepolymer having an isocyanate content of 3 to 12% by weight, and a non-mercury catalyst, wherein (i) the prepolymer is the reaction product of at least one polyether polyol having a number average hydroxyl equivalent weight of at least 800 with an excess of an aromatic polyisocyanate, (ii) the amount of prepolymer provided to the reaction mixture is sufficient to provide an isocyanate index of 80 to 130, (iii) wherein the non-mercury catalyst is a zinc carboxylate or a mixture of 98-99.99 weight percent of one or more zinc carboxylates and 0.01 to 2 weight percent of one or more zirconium carboxylates and (~~iiii~~iv) the reaction mixture is essentially devoid of mercury compounds, to at least a portion of the substrate and (2) at least partially curing the first reaction mixture to form the first section of syntactic polyurethane elastomer, and then

b) forming a second section of syntactic polyurethane elastomer on at least a portion of the substrate by (1) applying a second reaction mixture containing an alkylene glycol chain extender, 5 to 35 weight percent, based on the weight of the reaction mixture, of microspheres, an isocyanate-terminated prepolymer having an isocyanate content of 3 to 12% by weight, and a non-mercury catalyst, wherein (i) the prepolymer is the reaction product of at least one polyether polyol having a number average hydroxyl equivalent weight of at least 800 with an excess of an aromatic polyisocyanate, (ii) the amount of prepolymer provided to the reaction mixture is sufficient to provide an isocyanate index of 80 to 130, (iii) wherein the non-mercury catalyst is a zinc carboxylate or a mixture of 98-99.99 weight percent of one or more zinc carboxylates and 0.01 to 2 weight percent of one or more zirconium carboxylates and (~~iii~~iv) the reaction mixture is essentially devoid of mercury compounds to at least a portion of the substrate and in contact with the first section of syntactic polyurethane elastomer to form at least one bondline between the first section of syntactic polyurethane elastomer and the second reaction mixture and (2) at least partially curing the second reaction mixture to form the second section of syntactic polyurethane elastomer adherent to the first section of syntactic polyurethane elastomer.

4. The process of claim 3 wherein the bondline has a bond strength of at least 8.0 MPa as measured according to ASTM D638.

~~5. The process of claim 3 or 4 wherein the bondline has no visible defects when visualized microscopically at a magnification of 100X.~~

~~6~~5. The process of ~~any of~~ claim~~s~~ ~~2-5~~3 wherein the substrate is an undersea pipe or undersea architecture.

~~7~~6. The process of claim ~~6~~ 5 wherein the undersea pipe or undersea architecture is branched, curved or has another non-linear configuration.

~~8~~7. The process of claim 6 ~~or 7~~ wherein the undersea pipe or undersea architecture has one or more external features that protrude partially or completely through the applied syntactic polyurethane elastomer.

~~9~~8. The process of ~~any preceding~~ claim 3, wherein the polyether polyol used to make the isocyanate-terminated prepolymer is prepared by (A) adding propylene oxide and ethylene oxide to a difunctional or trifunctional initiator to produce a polyol having a hydroxyl equivalent weight of 1500 to 2500 and containing 5 to 30% by weight polymerized ethylene oxide, wherein the polymerized ethylene oxide is randomly polymerized with the propylene oxide, forms one or more internal blocks and/or forms terminal blocks that result in primary hydroxyl groups or (B). homopolymerizing propylene oxide or randomly copolymerizing 75-99.9 weight percent propylene oxide and 0.1 to 25 weight percent ethylene oxide onto a trifunctional initiator, and optionally capping the resulting polyether with up to 30% by weight (based on total product weight) ethylene oxide to form a polyether polyol having an equivalent weight of 1500 to 2500.

~~10~~9. The process of ~~any preceding~~ claim 8, wherein the chain extender is 1,4-butanediol.

~~11. The process of any preceding claim, wherein the non-mercury catalyst is a zinc carboxylate or a mixture of 98-99.99 weight percent of one or more zinc carboxylates and 0.01 to 2 weight percent of one or more zirconium carboxylates.~~

~~12~~10. The process of ~~any preceding~~ claim 3 wherein each respective reaction mixture contains 15 to 25 weight percent microspheres.

~~13. A cured syntactic polyurethane elastomer which is a reaction product of a reaction mixture comprising an alkylene glycol chain extender, 5 to 50 weight percent, based on the weight of the reaction mixture, of microspheres, an isocyanate-terminated prepolymer having an isocyanate content of 3 to 12% by weight, and a non-mercury catalyst, wherein (i) the prepolymer is the reaction product of at least one polyether polyol having a number average hydroxyl equivalent weight of at least 800 with an excess of an aromatic polyisocyanate, (ii) the amount of prepolymer provided to the reaction mixture is sufficient to provide an isocyanate index of 80 to 130, and (iii) the reaction mixture is essentially devoid of mercury compounds.~~