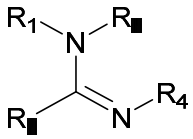
Claims

1. A fouling release coating composition free of tin compounds comprising:
   (a) a polysiloxane-based binder system comprising at least one curable polysiloxane-based binder A having a weight average Mw of 50,000 g/mol or less, such as 8,000 to 50,000 g/mol and wherein binder A constitutes at least 27 wt.% of the total polysiloxane-based binder system;
   (b) 0.05 to 5.0 dry wt% of at least one amidine or amine compound having a molecular weight of 1000 g/mol or less; and
   (c) at least one metal catalyst being a salt or organometallic compound of Zn, Li, K, Fe, Bi, Ce or Zr;

   wherein the at least one amidine compound is an amidine of formula:



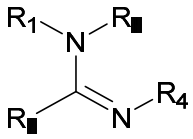
   wherein R_1, R_2, R_3, R_4 are each independently selected from hydrogen, monovalent organic groups, monovalent heteroorganic groups, and combinations thereof,

   wherein any two or more of R_1, R_2, R_3, R_4 optionally can be bonded together to form a ring structure; and

   wherein the at least one amine compound is an aminosilane.

2. A fouling release coating composition free of tin compounds comprising:
   (a) a polysiloxane-based binder system comprising at least one curable polysiloxane-based binder A having a viscosity of 2,800 mPas or less, such as 300 to 2800 mPas and wherein binder A constitutes at least 27 wt.% of the total polysiloxane-based binder system;
   (b) 0.05 to 5.0 dry wt% of at least one amidine or amine compound having a molecular weight of 1000 g/mol or less; and
   (c) at least one metal catalyst being a salt or organometallic compound of Zn, Li, K, Fe, Bi, Ce or Zr;

   wherein the at least one amidine compound is an amidine of formula:



wherein R_1, R_2, R_3, R_4 are each independently selected from hydrogen, monovalent organic groups, monovalent heteroorganic groups, and combinations thereof,

wherein any two or more of R_1, R_2, R_3, R_4 optionally can be bonded together to form a ring structure; and

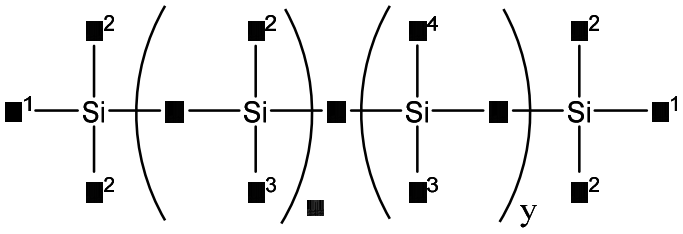
wherein the at least one amine compound is an aminosilane.

3. A fouling release coating composition as claimed in claim 1, wherein the polysiloxane-based binder system further comprises a curable polysiloxane-based binder B which is different from binder A and wherein the weight average Mw of binder B is 55,000 g/mol or more.

4. A fouling release coating composition as claimed in claim 2, wherein the polysiloxane-based binder system further comprises a curable polysiloxane-based binder B which is different from binder A and wherein the viscosity of binder B is 3500 mPas or more.

5. A fouling release coating composition as claimed in claim 3 or 4 wherein the mixture of the at least two polysiloxane binders has a PDI of more than 2.5.

6. A fouling release coating composition as claimed in any one of claims 1 to 5 wherein the polysiloxane-based binder A or B is of formula (D1):



(D1)

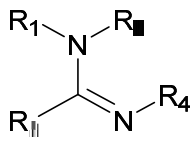
wherein

each R^1 is independently selected from a hydroxyl group, C_{1-6}-alkoxy group, or O-$Si(R^5)_{3-z}$ $(R^6)_z$;
each R^2 is independently selected from C_{1-10} alkyl, C_{6-10} aryl, C_{7-10} alkylaryl or C_{1-6} alkyl substituted by poly(alkylene oxide) and/or a group as described for R^1;
each R^3 and R^4 is independently selected from C_{1-10} alkyl, C_{6-10} aryl, C_{7-10} alkylaryl or C_{1-6} alkyl substituted by poly(alkylene oxide);
each R^5 is independently a hydrolysable group such as C_{1-6} alkoxy group, an acetoxy group, an enoxy group or ketoxy group;
each R^6 is independently selected from a C_{1-6} alkyl group;
z is 0 or an integer from 1-2;
x is an integer of at least 2;
y is an integer of at least 2.

7. A fouling release coating composition as claimed in any preceding claim wherein component (b) is an aminosilane.

8. A fouling release coating composition as claimed in any preceding claim wherein component (b) is an aminoalkyltrialkoxysilane or, bis(alkyltrialkoxysilyl)amine such as bis(3-propyltriethoxysilyl)amine or 3-aminopropyltriethoxy silane.

9. A fouling release coating composition as claimed in any preceding claim wherein component (b) is an amidine of formula:



wherein R_1, R_2, R_3, R_4 are each independently selected from hydrogen, monovalent organic groups, monovalent heteroorganic groups, and combinations thereof,
and wherein any two or more of R_1, R_2, R_3, R_4 optionally can be bonded together to form a ring structure.

10. A fouling release coating composition as claimed in any preceding claim wherein component (b) is 1,8-diazabicyclo 5.4.0-7-undecene (DBU).

11. A fouling release coating composition as claimed in claim 1 or 2, free of tin compounds, comprising (dry weight):

(a) at least 40 wt% of a polysiloxane-based binder system comprising at least two different curable polysiloxane-based binders A and B wherein the weight average Mw of binder A is 50,000 g/mol or less and the weight average Mw of binder B is 55,000 g/mol or more and wherein binder A constitutes at least 27 wt.% of the total polysiloxane-based binder system; or

at least 40 wt% of a polysiloxane-based binder system comprising at least two different curable polysiloxane-based binders A and B wherein the viscosity of binder A is 2,800 mPas or less and the viscosity of binder B is 3500 mPas or more and wherein binder A constitutes at least 27 wt.% of the total polysiloxane-based binder system; or

at least 40 wt% of a polysiloxane-based binder system comprising at least one curable polysiloxane-based binder having a Mw of 50000 g/mol or less wherein the binder constitutes at least 60 wt.% of the total polysiloxane-based binder system; or

at least 40 wt% of a polysiloxane-based binder system comprising at least one curable polysiloxane-based binder having a viscosity of 2,800 mPas or less wherein the binder constitutes at least 60 wt.% of the total polysiloxane-based binder system;

(b) 0.1 to 5.0 wt% of the at least one amidine or amine compound;
(c) 0.1 to 5.0 wt% of at least one metal catalyst being a salt or organometallic compound of Zn, Li, K, Fe, Bi or Zr;
(d) 0 to 30 wt%, preferably 1.0 to 30 wt% of a hydrophilic modified polysiloxane; and
(e) 0 to 8.0 wt%, preferably 2.0 to 8.0 wt% crosslinker.

12. A process for applying and curing a fouling release coating composition to a substrate, such as a marine substrate, comprising applying a fouling release coating composition as claimed in any preceding claim to a substrate and curing the fouling release coating composition at a temperature of 10ºC or less, e.g. 0 to 10 ºC.

13. A process as claimed in claim 12 wherein curing is effected at a temperature in the range of 0 to 10 ºC.

14. A substrate comprising a cured fouling release coating composition as claimed in claim 1 to 11.