The nanoimprinting lithography technique has found popularity as an alternative means of creating nanopatterns, compared to conventional lithography means. Some of these disadvantages inherent in the latter include the need to replace costly consumables, high error rates and the limitation to approximately a 1 to 1 replication of the desired patterns.

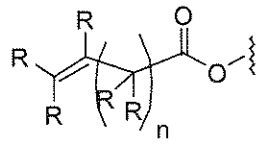
While well-defined, functional metal oxide nanostructures developed through the lithography process are much desired in view of their large potential in commercial applications, many technical difficulties have been apparent in the pursuit of highly efficient and reliable methods of developing such metal oxide features. For example, in cases where chemical formulations comprising different forms of acrylates have been considered, the stability of the formulation is generally poor, due to the tendency for some of the components to experience early, undesired polymerization in the lithographic process.

Accordingly, there is a need to provide suitable lithographic processes which will provide the efficient and cost-effective development of functional metal oxide nanoparticles by overcoming or at least ameliorating the technical difficulties and disadvantages described above.

Summary

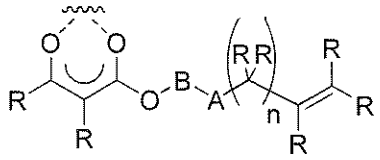
According to the present disclosure~~a first aspect~~, there is provided a process for making a patterned metal oxide structure comprising the step of heating an imprint structure comprising a polymerized organometallic compound to remove organic material and thereby form said patterned

metal oxide structure, wherein the imprint structure is formed by polymerizing a resist mixture comprising at least one olefinic polymerizable compound and a polymerizable organometallic compound having at least one carboxylate of Formula 1:



Formula 1

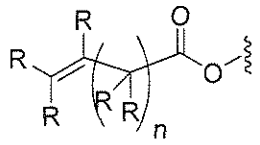
wherein n is 1-12; and each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl; or at least one acetoacetate of Formula 2:



Formula 2

wherein m is 0-12; n is 0-12; A is -(C=O)- or a bond; B is $-(CR_2)_mO-$, $-(CR_2CR_2O)_m-$, or a bond; and each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl.

According to a first aspect, there is provided a process for making a patterned metal oxide structure comprising the step of heating an imprint structure comprising a polymerized organometallic compound to remove organic material and thereby form said patterned metal oxide structure, wherein the imprint structure is formed by polymerizing a resist mixture comprising at least one olefinic polymerizable compound and a polymerizable organometallic compound having at least one carboxylate of Formula 1:

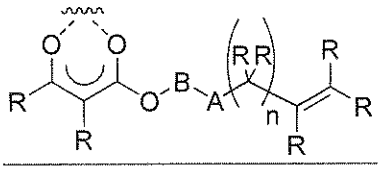


Formula 1

wherein

n is 1-12; and

each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl; or at least two acetoacetate of Formula 2:



Formula 2

wherein

m is 0-12;

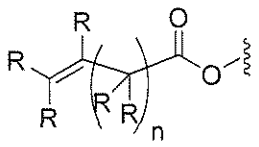
n is 0-12;

A is -(C=O)- or a bond; B is $-(CR_2)_mO-$, $-(CR_2CR_2O)_m-$, or a bond; and each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl.

According to the present disclosure~~a second aspect~~, there is provided a process for making a patterned metal oxide structure comprising the steps of:

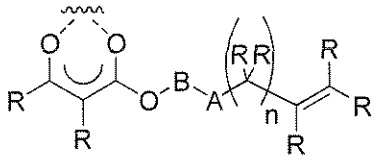
(a) polymerizing a resist mixture, while in contact with a mold having imprint forming patterns thereon, to thereby form an imprint structure comprising the polymerized organometallic compound, said resist mixture comprising at least one olefinic polymerizable compound and a polymerizable

organometallic compound having at least one carboxylate of Formula 1:



Formula 1

wherein n is 1-12; and each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl; or at least one acetoacetate of Formula 2:



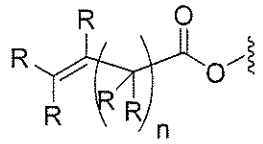
Formula 2

wherein m is 0-12; n is 0-12; A is -(C=O)- or a bond; B is $-(CR_2)_mO-$, $-(CR_2CR_2O)_m-$, or a bond; and each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl; and

(b) heating said imprint structure to remove organic material and thereby form said patterned metal oxide structure.

According to another aspect, there is provided a process for making a patterned metal oxide structure comprising the steps of:

(a) polymerizing a resist mixture, while in contact with a mold having imprint forming patterns thereon, to thereby form an imprint structure comprising the polymerized organometallic compound, said resist mixture comprising at least one olefinic polymerizable compound and a polymerizable organometallic compound having at least one carboxylate of Formula 1:

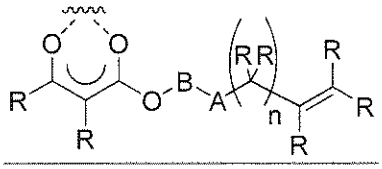


Formula 1

wherein

n is 1-12; and

each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl; or at least two acetoacetate of Formula 2:



Formula 2

wherein

m is 0-12;

n is 0-12;

A is -(C=O)- or a bond; B is $-(CR_2)_mO-$, $-(CR_2CR_2O)_m-$, or a bond; and each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl; and

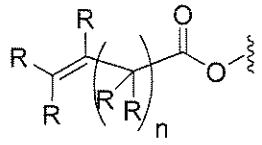
(b) heating said imprint structure to remove organic material and thereby form said patterned metal oxide structure.

According to the present disclosure~~a third aspect~~, there is provided a process for forming a plurality of patterned metal oxide structures comprising the steps of:

(a) polymerizing a resist mixture, while in contact with a mold having imprint forming patterns thereon, to thereby form an imprint structure comprising the polymerized organometallic compound on a first area of a substrate, said resist mixture comprising at least one olefinic polymerizable compound and a

According to another aspect, there is provided a process for forming a plurality of patterned metal oxide structures comprising the steps of:

(a) polymerizing a resist mixture, while in contact with a mold having imprint forming patterns thereon, to thereby form an imprint structure comprising the polymerized organometallic compound on a first area of a substrate, said resist mixture comprising at least one olefinic polymerizable compound and a polymerizable organometallic compound having at least one carboxylate of Formula 1:

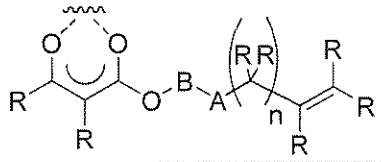


Formula 1

wherein

n is 1-12; and

each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl; or at least two acetoacetate of Formula 2:



Formula 2

wherein

m is 0-12;

n is 0-12;

A is -(C=O)- or a bond; B is $-(CR_2)_mO-$, $-(CR_2CR_2O)_m-$, or a bond; and each R is independently selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, cycloakenyl, aryl, and aralkyl;

(b) heating said imprint structure on said first area to remove organic material and thereby form said patterned metal oxide structure on said first area; and

(c) repeating steps (a) and (b) on a second area of said substrate in order to form said plurality of patterned metal oxide structures throughout the substrate.