inherent to high entropy oxides. Such properties include thermal conductivity, specific heat, and toughness.

SUMMARY

[0008] The present disclosure provides a class of oxide coating compositions that can be applied via thermal spray techniques to engine components of any composition, which exhibit low thermal inertia and effective temperature swing properties. The coating allows for increased fuel efficiency in combustion engines.

[0009] Examples of the present disclosure relate to a high entropy oxide (HEO) material as temperature swing coating. In one aspect, there is provided a high entropy oxide (HEO) material comprising a thermal conductivity lower than 1.5 W m^{-1} K^{-1}, characterized in that the HEO material comprises: 0.4-0.6 wt% MO oxides; 1.2-1.8 wt% Y_2O_3; 5.5-9 wt% M_2O_3 oxides; 13-21 wt% MO_2; and a balance of ZrO_2 where M represents a group of at least five different oxide-forming metallic cations, wherein the HEO material has a total scattering value for the high entropy oxide of 36.6 or higher and a furnace cycle test lifetime of 370-390 cycles when sprayed directly onto a bond coat. In examples, the HEO material allows for precise tunability of chemical, mechanical, and thermal properties for use in specific environments. In examples, HEO materials contain high concentrations (>5 mol%) of at least five oxide constituents. The chemical disorder in the oxide systems creates significant phonon scattering leading to an inherently low thermal conductivity. Compositional control allows for compositions with low specific heat capacity and, therefore, low thermal inertia, which is defined as the square root of the product of the heat capacity, thermal conductivity, and density.

[0010] The compositions that maximize atomic size and mass variance provide the most phonon scattering and the lowest thermal conductivity. Compositions with the lowest average atomic mass have the lowest specific heat capacity and density. The proper

combination of low thermal conductivity and low heat capacity provides the disclosed oxides with low thermal inertia and good temperature swing properties.

[0010a] In another aspect, there is provided an HEO material comprising: 0.4-0.6 wt% MO oxides; 1.2-1.8 wt% Y_2O_3; 5.5-9 wt% M_2O_3 oxides; 2-4 wt% MO_2 oxides; and a balance of ZrO_2.

What is claimed:

1. A high entropy oxide (HEO) material comprising a thermal conductivity lower than 1.5 W m^{-1} K^{-1}, characterized in that

the HEO material comprises:

0.4-0.6 wt% MO oxides;

1.2-1.8 wt% Y_2O_3;

5.5-9 wt% M_2O_3 oxides;

13-21 wt% MO_2; and

a balance of ZrO_2,

where M represents a group of at least five different oxide-forming metallic cations, wherein the HEO material has a total scattering value for the high entropy oxide of 36.6 or higher and a furnace cycle test lifetime of 370-390 cycles when sprayed directly onto a bond coat.

2. The HEO material of Claim 1, further comprising a specific heat capacity of less than 3.0 J m^{-2} K^{-1} $s^{-1/2}$.

3. The HEO material of Claim 1, further comprising a specific heat capacity of less than 900 J kg^{-1} K^{-1}.

4. The HEO material of Claim 1, wherein greater than 90% of the HEO material is a tetragonal structure.

5. The HEO material of Claim 1, wherein the HEO material has an oxide vacancy concentration of 0.05 or less.

6. The HEO material of Claim 1, further comprising the use of the material to form a thermal barrier coating.

7. The HEO material of Claim 1, further comprising the use of the material to form a coating for combustion chambers.

8. The HEO material of claim 1, wherein the HEO material is represented by General Formula of M_xO_y, where M represents a group of at least five different oxide-forming metallic cations, x represents the number of metal cations (M) or atoms, and y represents the number of oxygen anions (O) or atoms.

9. The HEO material of claim 1, wherein the HEO material is represented by General Formula of M_xO_y, where M represents at least one member of Group II of the Periodic Table, x represents the number of metal cations (M) or atoms, and y represents the number of oxygen anions (O) or atoms.

10. The HEO material of claim 1, wherein the HEO material is represented by General Formula of M_xO_y, where M represents at least one lanthanide, x represents the number of metal cations (M) or atoms, and y represents the number of oxygen anions (O) or atoms.

11. The HEO of claim 1, wherein the HEO material is represented by General Formula of M_xO_y, where M represents at least one transition metal, x represents the number of metal cations (M) or atoms, and y represents the number of oxygen anions (O) or atoms.

12. The HEO material of Claim 1, wherein the HEO material comprises:

7.5-11.5 wt% Y_2O_3;

13-20 wt% M_2O_3 oxides;

17-26 wt% MO_2 oxides; and

a balance of ZrO_2.

13. The HEO material of Claim 1, wherein the HEO material comprises:

6-9 wt% MO oxides;

0.5-1.5 wt% Y_2O_3;

2.5-4 wt% M_2O_3 oxides; and

a balance of ZrO_2.

14. An HEO material comprising:

0.4-0.6 wt% MO oxides;

1.2-1.8 wt% Y_2O_3;

5.5-9 wt% M_2O_3 oxides;

2-4 wt% MO_2 oxides; and

a balance of ZrO_2.

15. The HEO material of Claim 1, wherein the MO oxides are MgO, wherein the M_2O_3 oxides are selected from the group consisting of Yb_2O_3, La_2O_3, Gd_2O_3, and Dy_2O_3, and wherein the MO_2 oxides are selected from the group consisting of CeO_2, HfO_2, and TiO_2.