WHAT IS CLAIMED IS:

1. A scintillator composition, comprising the following and any reaction products thereof:

a matrix material, comprising:

a first component of at least one element selected from the group consisting of alkali metals and thallium;

a second component of at least one element, different from said at least one element of said first component, selected from the group consisting of alkali metals;

a third component of at least one element selected from the group consisting of lanthanides;

a fourth component of at least two elements selected from the group consisting of halogens; and

an activator for the matrix material, comprising cerium.

2. The scintillator composition of claim 1, wherein said alkali metal of said first component is selected from the group consisting of potassium, rubidium, cesium and combinations thereof.

3. The scintillator composition of claim 1, wherein said alkali metal of said second component is selected from the group consisting of lithium, sodium and combinations thereof.

4. The scintillator composition of claim 1, wherein said lanthanide of said third component is lanthanum.

5. The scintillator composition of claim 1, wherein said halogens of said fourth component are selected from the group consisting of fluorine, chlorine, bromine, iodine and combinations thereof.

6. The scintillator composition of claim 1, wherein said halogens of said fourth component are bromine and iodine in a ratio of two to one respectively.

7. The scintillator composition of claim 1, wherein said activator is present at a level in the range of about 1 mole percent to about 20 mole percent, based on total moles of activator and matrix material.

8. The scintillator composition of claim 1, wherein the matrix material comprises a compound of the formula A_2BLnX_6 wherein A is at least one element selected from the group consisting of alkali metals and thallium; B is at least one element, different from said A element, selected from the group consisting of alkali metals; Ln is at least one element selected from the group consisting of lanthanides; and X is at least two elements selected from the group consisting of halogens, and combinations thereof.

9. The scintillator composition of claim 8, wherein Ln is lanthanum.

10. The scintillator composition of claim 8, wherein X is bromine and iodine in a ratio of two to one respectively.

11. The scintillator composition of claim 1, wherein the matrix material further comprises bismuth.

12. The scintillator composition of claim 11, wherein said bismuth is present at a level of about 1 mole percent to about 40 mole percent, based on total moles of activator and matrix material.

13. The scintillator composition of claim 1, wherein the matrix material comprises at least one compound selected from the group consisting of $Cs_2NaLaBr_5I$, $Cs_2NaLaBr_4I_2$, $Cs_2NaLaBr_3I_3$, $Cs_2NaLaBr_2I_4$, $Cs_2NaLaBr_1I_5$; and $Cs_2Na(La_{1-x}Ce_x)Br_4I_2$, wherein $0.01 \leq x \leq 1.00$.

14. A radiation detector apparatus for detecting high energy radiation, said apparatus comprising:

a crystal scintillator which comprises the following composition, and any reaction products thereof:

a matrix material, comprising:

a first component of at least one element selected from the group consisting of alkali metals and thallium;

a second component (106) of at least one element, different from said at least one element of said first component, selected from the group consisting of alkali metals;

a third component of at least one element selected from the group consisting of lanthanides;

a fourth component of at least two elements selected from the group consisting of halogens; and

an activator for said matrix material, comprising cerium; and

a photodetector optically coupled to said crystal scintillator and configured to produce an electrical signal in response to the emission of a light pulse produced by said crystal scintillator.

15. The radiation detector apparatus of claim 14, wherein said alkali metal of said first component is selected from the group consisting of potassium, rubidium, cesium and combinations thereof.

16. The radiation detector apparatus of claim 14, wherein said alkali metal of said second component is selected from the group consisting of lithium, sodium and combinations thereof.

17. The radiation detector apparatus of claim 14, wherein said lanthanides of said third component is lanthanum.

18. The radiation detector apparatus of claim 14, wherein said halogens of said fourth component are selected from the group consisting of fluorine, chlorine, bromine, iodine and combinations thereof.

19. A method for detecting high-energy radiation with a scintillation detector, said method comprising:

receiving radiation by a scintillator crystal, so as to produce photons which are characteristic of the radiation; and

detecting the photons with a photon detector coupled to the scintillator crystal;

wherein the scintillator crystal is formed of a composition comprising the following, and any reaction products thereof:

a matrix material, comprising:

a first component of at least one element selected from the group consisting of alkali metals and thallium;

a second component of at least one element, different from said at least one element of said first component, selected from the group consisting of alkali metals;

a third component of at least one element selected from the group consisting of lanthanides;

a fourth component of at least two elements selected from the group consisting of halogens; and

an activator for the matrix material, comprising cerium.

20. The method of claim 19, wherein the matrix material comprises a compound of the formula A_2BLnX_6 wherein A is at least one element selected from the group consisting of alkali metals and thallium; B is at least one element, different from said A element, selected from the group consisting of alkali metals; Ln is at least one element selected from the group consisting of lanthanides; and X is at least two elements selected from the group consisting of halogens, and combinations thereof.

CLAIMS

1. A scintillator composition comprising the following and any reaction products thereof:

a matrix material comprising:

a first component of at least one element selected from the group consisting of alkali metals and thallium;

a second component of at least one element, different from the at least one element of the first component, selected from the group consisting of alkali metals;

a third component of at least one element selected from the group consisting of lanthanides; and

a fourth component of at least two elements selected from the group consisting of halogens; and

an activator for the matrix material, comprising cerium[[.]];

wherein the scintillator composition is a Ce3+ activated mixed halide elpasolite; and

wherein the alkali metal of the first component is selected from the group consisting of potassium, rubidium, cesium and combinations thereof, the alkali metal of the second component is selected from the group consisting of lithium, sodium and combinations thereof; and the lanthanide of the third component is lanthanum.

2. The scintillator composition of claim 1, wherein the halogens of the fourth component are selected from the group consisting of fluorine, chlorine, bromine, iodine and combinations thereof.

3. The scintillator composition of claim 1, wherein the halogens of the fourth component are bromine and iodine in a ratio of two to one, respectively.

4. The scintillator composition of claim 1, wherein the activator is present at a level in the range of about 1 mole percent to about 20 mole percent, based on total moles of activator and matrix material.

5. The scintillator composition of claim 1, wherein the matrix material comprises a compound of the formula A_2BLnX_6, wherein:

A is the first component;

B is the second component;

Ln is the third component; and

X is the fourth component.

6. The scintillator composition of claim 5, wherein X is bromine and iodine in a ratio of two to one, respectively.

7. The scintillator composition of claim 1, wherein the matrix material further comprises bismuth.

8. The scintillator composition of claim 7, wherein the bismuth is present at a level of about 1 mole percent to about 40 mole percent, based on total moles of activator and matrix material.

9. The scintillator composition of claim 1, wherein the matrix material comprises at least one compound selected from the group consisting of $Cs_2NaLaBr_5I$, $Cs_2NaLaBr_4I_2$, $Cs_2NaLaBr_3I_3$, $Cs_2NaLaBr_2I_4$, $Cs_2NaLaBr_1I_5$; and $Cs_2Na(La_{1-x}Ce_x)Br_4I_2$, wherein $0.01 \leq x \leq 1.00$.

10. A radiation detector apparatus for detecting high-energy radiation, the apparatus comprising:

a Ce3+ activated mixed halide elpasolite crystal scintillator, which comprises the following composition, and any reaction products thereof:

a matrix material, comprising:

a first component of at least one element selected from the group consisting of alkali metals and thallium;

a second component of at least one element, different from the at least one element of the first component, selected from the group consisting of alkali metals;

a third component of at least one element selected from the group consisting of lanthanides; and

a fourth component of at least two elements selected from the group consisting of halogens; and

an activator for the matrix material, comprising cerium; and

a photodetector optically coupled to the crystal scintillator and configured to produce an electrical signal in response to the emission of a light pulse produced by the crystal scintillator[[.]];

wherein the alkali metal of the first component is selected from the group consisting of potassium, rubidium, cesium and combinations thereof, the alkali metal of the second component is selected from the group consisting of lithium, sodium and combinations thereof; and the lanthanide of the third component is lanthanum.

11. The radiation detector apparatus of claim 10, wherein the halogens of the fourth component are selected from the group consisting of fluorine, chlorine, bromine, iodine and combinations thereof.

12. A method for detecting high-energy radiation with a scintillation detector, the method comprising:

receiving radiation by a scintillator crystal, so as to produce photons which are characteristic of the radiation; and

detecting the photons with a photon detector coupled to the scintillator crystal;

wherein the scintillator crystal is formed of a Ce3+ activated mixed halide elpasolite composition comprising the following, and any reaction products thereof:

a matrix material, comprising:

a first component of at least one element selected from the group consisting of alkali metals and thallium;

a second component of at least one element, different from the at least one element of the first component, selected from the group consisting of alkali metals;

a third component of at least one element selected from the group consisting of lanthanides; and

a fourth component of at least two elements selected from the group consisting of halogens; and

an activator for the matrix material, comprising cerium[[.]];

wherein the alkali metal of the first component is selected from the group consisting of potassium, rubidium, cesium and combinations thereof, the alkali metal of the second component is selected from the group consisting of lithium, sodium and combinations thereof; and the lanthanide of the third component is lanthanum.

13. The method of claim 12, wherein the matrix material comprises a compound of the formula A_2BLnX_6 wherein:

A is the first component;

B is the second component;

Ln is the third component; and

X is the fourth component.