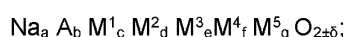


CLAIMS:

- 1 An O3/P2 mixed-phase sodium-containing doped layered oxide material which
comprises a mixture of phases, wherein a first phase has an O3-type structure and a
5 second phase has a P2-type structure; further wherein the O3/P2 mixed-phase
sodium-containing doped layered oxide material has the general formula:



- 10 wherein:

A is an alkali metal selected from at least one of lithium and potassium;

M¹ is one or more metals with an average oxidation state of 2+;

M² is one or more metals with an average oxidation state of 4+;

M³ is one or more metals with an average oxidation state of 2+;

- 15 M⁴ is one or more metals with an average oxidation state of 4+; and

M⁵ is one or more metals with an average oxidation state of 3+;

wherein:

a>0;

- 20 a>b;

0.75 ≤ (a+b) ≤ 1.0;

0 ≤ c < 0.5;

at least one of d and f is > 0;

e > 0;

- 25 0 ≤ g < 0.5;

0 ≤ δ ≤ 0.1;

wherein: a, b, c, d, e, f and g are chosen to maintain electroneutrality;

- 30 wherein the O3/P2 mixed phase sodium-containing doped layered oxide material
comprises 1 to 99 % of the first phase, and 99 to 1 % of the second phase, based on
the combined total number of moles of the first and second phases present in the
O3/P2 mixed-phase sodium-containing doped layered oxide material;

- 35 and wherein the O3/P2 mixed-phase sodium-containing doped layered oxide material
is neither a material with the general formula $\text{Na}_{0.833}\text{Ni}_{0.317}\text{Mn}_{0.467}\text{Mg}_{0.100}\text{Ti}_{0.117}\text{O}_2$ which

comprises a mixture of phases in which a first phase has an O3-type structure and a second phase has a P2-type structure, wherein the amount of the first phase is 63% and the amount of the second phase is 37%, based on the combined total number of moles of the first and second phases present in the O3/P2 mixed-phase sodium-containing doped layered oxide material; nor a material with the general formula $\text{Na}_{0.95}\text{Ni}_{0.3167}\text{Mn}_{0.3167}\text{Mg}_{0.1583}\text{Ti}_{0.2083}\text{O}_2$ which comprises a mixture of phases in which a first phase has an O3-type structure and a second phase has a P2-type structure, wherein the amount of the first phase is 97% and the amount of the second phase is 3%, based on the combined total number of moles of the first and second phases in the O3/P2 mixed-phase sodium-containing doped layered oxide material.

2. An O3/P2 mixed-phase sodium-containing doped layered oxide material according to claim 1, selected from:

$\text{NaNi}_{0.400}\text{Mn}_{0.490}\text{Mg}_{0.100}\text{Ti}_{0.010}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

$\text{Na}_{0.95}\text{Ni}_{0.3167}\text{Mn}_{0.3167}\text{Mg}_{0.1583}\text{Ti}_{0.2083}\text{O}_2$ (comprising 1% to 99%, but not 97%, of a first phase with an O3-type structure and 99% to 1%, but not 3%, of a second phase with a P2-type structure);

$\text{Na}_{0.925}\text{Ni}_{0.4525}\text{Mn}_{0.5275}\text{Mg}_{0.01}\text{Ti}_{0.01}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

$\text{Na}_{0.867}\text{Ni}_{0.383}\text{Mn}_{0.467}\text{Mg}_{0.05}\text{Ti}_{0.1}\text{O}_2$ (comprising 1% to 99 of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

$\text{Na}_{0.833}\text{Ni}_{0.317}\text{Mn}_{0.467}\text{Mg}_{0.1}\text{Ti}_{0.117}\text{O}_2$ (comprising 1% to 99%, but not 63%, of a first phase with an O3-type structure and 99% to 1%, but not 37%, of a second phase with a P2-type structure);

$\text{Na}_{0.8}\text{Ni}_{0.35}\text{Mn}_{0.48}\text{Mg}_{0.05}\text{Ti}_{0.12}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

$\text{Na}_{0.77}\text{Ni}_{0.28}\text{Mn}_{0.31}\text{Mg}_{0.05}\text{Ti}_{0.25}\text{Fe}_{0.11}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

- $\text{Na}_{0.77}\text{Ni}_{0.225}\text{Mn}_{0.115}\text{Mg}_{0.01}\text{Ti}_{0.35}\text{Fe}_{0.3}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.867}\text{Ni}_{0.333}\text{Mn}_{0.467}\text{Mg}_{0.1}\text{Ti}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 5 $\text{Na}_{0.833}\text{Ni}_{0.317}\text{Mn}_{0.417}\text{Mg}_{0.05}\text{Ti}_{0.117}\text{Co}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.867}\text{Ni}_{0.383}\text{Mn}_{0.467}\text{Mg}_{0.05}\text{Ti}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 10 $\text{Na}_{0.85}\text{Ni}_{0.325}\text{Mn}_{0.525}\text{Mg}_{0.100}\text{Ti}_{0.05}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.85}\text{Ni}_{0.325}\text{Mn}_{0.499}\text{Mg}_{0.100}\text{Ti}_{0.076}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.77}\text{Ni}_{0.305}\text{Mn}_{0.51}\text{Mg}_{0.025}\text{Ti}_{0.05}\text{Al}_{0.055}\text{Co}_{0.055}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 15 $\text{Na}_{0.77}\text{Ni}_{0.305}\text{Mn}_{0.535}\text{Mg}_{0.025}\text{Ti}_{0.025}\text{Al}_{0.055}\text{Co}_{0.055}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{NaNi}_{0.4}\text{Mn}_{0.49}\text{Mg}_{0.1}\text{Ti}_{0.01}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 20 $\text{Na}_{0.77}\text{Ni}_{0.28}\text{Mn}_{0.51}\text{Mg}_{0.05}\text{Ti}_{0.05}\text{Al}_{0.055}\text{Co}_{0.055}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.833}\text{Fe}_{0.200}\text{Mn}_{0.483}\text{Mg}_{0.0917}\text{Cu}_{0.225}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 25 $\text{NaLi}_{0.05}\text{Ni}_{0.3}\text{Mn}_{0.525}\text{Mg}_{0.025}\text{Cu}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.775}\text{Ni}_{0.35}\text{Mn}_{0.475}\text{Ti}_{0.1}\text{Al}_{0.075}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure); and

$\text{Na}_{0.833}\text{Ca}_{0.05}\text{Ni}_{0.3417}\text{Mn}_{0.4417}\text{Mg}_{0.125}\text{Ti}_{0.0917}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

Wherein the percentage values for each of the first and second phases are based on the combined total number of moles of the first and second phases present in the O3/P2 mixed phase sodium-containing doped layered oxide material.

3. A process of preparing an O3/P2 mixed-phase sodium-containing doped layered oxide material according to either of claims 1 or 2, comprising the steps:

- i) forming a mixture of precursor materials to provide metal atoms in the stoichiometric ratios that are present in the O3/P2 mixed-phase sodium-containing doped layered oxide material of the general formula; and
- ii) heating the resulting mixture of precursor materials at a temperature of at least 500°C to yield the O3/P2 mixed-phase sodium-containing doped layered oxide material,

wherein the mixed phase sodium-containing doped layered oxide material comprises a mixture of phases in which a first phase has an O3-type structure and a second phase has a P2-type structure, wherein the amount of the first phase is 1 to 99 % and the amount of the second phase is 99 to 1 %, based on the combined total number of moles of the first and second phases present in the O3/P2 mixed-phase sodium-containing doped layered oxide material;

wherein the process does not involve either:

- i) forming a mixture of precursor materials which provide metal atoms in the stoichiometric ratios that are present in an O3/P2 mixed-phase sodium-containing doped layered oxide material with the formula $\text{Na}_{0.833}\text{Ni}_{0.317}\text{Mn}_{0.467}\text{Mg}_{0.100}\text{Ti}_{0.117}\text{O}_2$ and
- ii) heating the resulting mixture at 900°C for 10 hours to produce a O3/P2 mixed-phase sodium-containing doped layered oxide material which comprises a mixture of phases in which a first phase has an O3-type structure and a second phase has a P2-type structure, wherein the amount of the first phase is 63% and the amount of the second phase is 37%, based on the combined total number of moles of the first and second phases present in the O3/P2 mixed-phase sodium-containing doped layered oxide material;

or

- 5 i) forming a mixture of precursor materials which provide metal atoms in the stoichiometric ratios that are present in an O3/P2 mixed-phase sodium-containing doped layered oxide material with the formula $\text{Na}_{0.95}\text{Ni}_{0.3167}\text{Mn}_{0.3167}\text{Mg}_{0.1583}\text{Ti}_{0.2083}\text{O}_2$ and
- 10 ii) heating the resulting mixture at 900°C for 4 minutes to produce a O3/P2 mixed-phase sodium-containing doped layered oxide material which comprises a mixture of phases in which a first phase has an O3-type structure and a second phase has a P2-type structure, wherein the amount of the first phase is 97 % and the amount of the second phase is 3%, based on the combined total number of moles of the first and second phases present in the O3/P2 mixed-phase sodium-containing doped layered oxide material.

15

4. A process according to claim 3 for preparing O3:P2 mixed-phase sodium-containing doped layered oxide materials selected from:

$\text{NaNi}_{0.400}\text{Mn}_{0.490}\text{Mg}_{0.100}\text{Ti}_{0.010}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

- 20 $\text{Na}_{0.95}\text{Ni}_{0.3167}\text{Mn}_{0.3167}\text{Mg}_{0.1583}\text{Ti}_{0.2083}\text{O}_2$ (comprising 1% to 99%, but not 97%, of a first phase with an O3-type structure and 99% to 1%, but not 3%, of a second phase with a P2-type structure);

$\text{Na}_{0.925}\text{Ni}_{0.4525}\text{Mn}_{0.5275}\text{Mg}_{0.01}\text{Ti}_{0.01}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

- 25 $\text{Na}_{0.867}\text{Ni}_{0.383}\text{Mn}_{0.467}\text{Mg}_{0.05}\text{Ti}_{0.1}\text{O}_2$ (comprising 1% to 99 of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

$\text{Na}_{0.833}\text{Ni}_{0.317}\text{Mn}_{0.467}\text{Mg}_{0.1}\text{Ti}_{0.117}\text{O}_2$ (comprising 1% to 99%, but not 63%, of a first phase with an O3-type structure and 99% to 1%, but not 37%, of a second phase with a P2-type structure);

- 30 $\text{Na}_{0.8}\text{Ni}_{0.35}\text{Mn}_{0.48}\text{Mg}_{0.05}\text{Ti}_{0.12}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

- $\text{Na}_{0.77}\text{Ni}_{0.28}\text{Mn}_{0.31}\text{Mg}_{0.05}\text{Ti}_{0.25}\text{Fe}_{0.11}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.77}\text{Ni}_{0.225}\text{Mn}_{0.115}\text{Mg}_{0.01}\text{Ti}_{0.35}\text{Fe}_{0.3}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 5 $\text{Na}_{0.867}\text{Ni}_{0.333}\text{Mn}_{0.467}\text{Mg}_{0.1}\text{Ti}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.833}\text{Ni}_{0.317}\text{Mn}_{0.417}\text{Mg}_{0.05}\text{Ti}_{0.117}\text{Co}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 10 $\text{Na}_{0.867}\text{Ni}_{0.383}\text{Mn}_{0.467}\text{Mg}_{0.05}\text{Ti}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.85}\text{Ni}_{0.325}\text{Mn}_{0.525}\text{Mg}_{0.100}\text{Ti}_{0.05}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.85}\text{Ni}_{0.325}\text{Mn}_{0.499}\text{Mg}_{0.100}\text{Ti}_{0.076}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 15 $\text{Na}_{0.77}\text{Ni}_{0.305}\text{Mn}_{0.51}\text{Mg}_{0.025}\text{Ti}_{0.05}\text{Al}_{0.055}\text{Co}_{0.055}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.77}\text{Ni}_{0.305}\text{Mn}_{0.535}\text{Mg}_{0.025}\text{Ti}_{0.025}\text{Al}_{0.055}\text{Co}_{0.055}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 20 $\text{NaNi}_{0.4}\text{Mn}_{0.49}\text{Mg}_{0.1}\text{Ti}_{0.01}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{Na}_{0.77}\text{Ni}_{0.28}\text{Mn}_{0.51}\text{Mg}_{0.05}\text{Ti}_{0.05}\text{Al}_{0.055}\text{Co}_{0.055}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- 25 $\text{Na}_{0.833}\text{Fe}_{0.200}\text{Mn}_{0.483}\text{Mg}_{0.0917}\text{Cu}_{0.225}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);
- $\text{NaLi}_{0.05}\text{Ni}_{0.3}\text{Mn}_{0.525}\text{Mg}_{0.025}\text{Cu}_{0.1}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

$\text{Na}_{0.775}\text{Ni}_{0.35}\text{Mn}_{0.475}\text{Ti}_{0.1}\text{Al}_{0.075}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure); and

$\text{Na}_{0.833}\text{Ca}_{0.05}\text{Ni}_{0.3417}\text{Mn}_{0.4417}\text{Mg}_{0.125}\text{Ti}_{0.0917}\text{O}_2$ (comprising 1% to 99% of a first phase with an O3-type structure and 99% to 1% of a second phase with a P2-type structure);

wherein the percentage values for each of the first and second phases are based on the combined total number of moles of the first and second phases present in the O3/P2 mixed phase sodium-containing doped layered oxide material.

5. An energy storage device comprising one or more O3/P2 mixed-phase sodium-containing doped layered oxide materials according to either of claims 1 or 2.
6. An energy storage device according to claim 5 selected from a battery, a rechargeable battery, an electrochemical device and an electrochromic device.
7. An electrode comprising one or more O3/P2 mixed-phase sodium-containing doped layered oxide materials according to either of claims 1 or 2.