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Lithium — Vocabulary

WD stage

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Foreword

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This document was prepared by Technical Committee ISO/TC 333, Lithium.

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Introduction

Lithium minerals, lithium compounds, lithium and lithium alloys, and cathode materials are widely used. Different business and industry sectors have various descriptions for lithium compounds, alloys, and cathode materials. Therefore, it is of vital importance to unify the terminology used in the lithium industry.

The spodumene, brine, and lepidolite are the main resource of lithium. Various lithium compounds and alloys are obtained from spodumene, brines and lepidolite as they are processed through to intermediate products and on to final products like cathode materials, lithium-ion battery, etc.

This document is expected to be used by producers, consumers and traders in the field of lithium minerals, compounds, alloys, cathode materials and scrap recycling. This document can serve as a reference that will help to reduce discrepancies or trade disputes caused by inconsistencies in concepts used when dealing with lithium minerals, compounds, alloys, cathode materials and scrap recycling.

Lithium — Vocabulary

1 Scope

This document can be used as a reference for lithium minerals, lithium metals, lithium compounds, lithium alloys, and lithium cathode materials and scrap recycling as well as for the relevant production processes and product quality characteristics.

This document can be used as a reference to unify concepts in lithium minerals, compounds, alloys, cathode materials, and scrap recycling production, application, inspection, circulation, trading, scientific research and education.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

3.1 Generic concepts

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
lithium
chemical element of the alkali metal group

3.1.2
lithium content
mass fraction of *lithium* (3.1.1) in material

3.1.3
lithium cathode materials
multi - metal oxide material to which lithium is added to perform redox reactions during charge/discharge process in lithium-ion batteries

3.2 Terms related to lithium minerals

3.2.1
spodumene
pegmatite-hosted silicate mineral (clinopyroxene group), mainly containing lithium and aluminium, with typical chemical formula of $LiAlSi_2O_6$

Note 1 to entry: Spodumene contains a theoretical 5.5% - 8.1% lithium oxide.

3.2.2
lepidolite
pegmatite- and greisen-hosted mica mineral of containing potassium and lithium with typical chemical formula of composition $KLi_2AlSi_3O_{10}(OH,F)_2$

Note 1 to entry: Lepidolites contains a theoretical 3.20% - 6.45% lithium oxide.

3.2.3
zinnwaldite
greisen- (altered roof portion of granite) hosted mica mineral with typical chemical formulae of $KLi_2Al(Si_4O_{10})(F,OH)_2$

Note 1 to entry: Zinnwaldite contains a theoretical 7.1% - 10.1% lithium oxide.

3.2.4
lithium clay
sedimentary rock or volcanic rock-hosted silicate clay minerals containing lithium. Most important lithium clay mineral examples are:
a) jadarite with typical formula of $LiNaSiB_3O_7(OH)$ (in sedimentary rocks) and
b) hectorite with typical formula of $Na_{0.3}(Mg,Li)_3(Si_4O_{10})(F,OH)_2{\cdot}nH_2O$

Note 1 to entry: Jadarite contains a theoretical 7.3% lithium oxide.

Note 2 to entry: Hectorite contains a theoretical 1.0% - 3.0% lithium oxide.

3.2.5
lithium brine and Li-bearing ground water
Salt lake brine, saline underground brine, or ground water containing anomalously high concentrations of lithium. Natural Li^+ contents can range between more than 1,000 mg/L in mine waters and ground waters and up to 2,000 mg/L in saline brines of desert regions

Note 1 to entry: More lithium minerals details are given as Annex A.

3.2.6 lithium mineral concentrates

result of a process that enriches the content of specified minerals or its compounds

3.2.6.1
spodumene concentrate
concentrate (3.2.6) of spodumene ore with *lithium content* (3.1.2) expressed as percentage of lithium oxide

Note 1 to entry: *Spodumene concentrate* contains typically 5.0% - 7.5% lithium oxide.

3.2.6.2
lepidolite concentrate
concentrate (3.2.6) of lepidolite ore with *lithium content* (3.1.2) expressed as percentage of lithium oxide

Note 1 to entry: *Lepidolite concentrate* contains typically 2.5% - 4.4% lithium oxide.

3.2.6.3
zinnwaldite concentrate
concentrate (3.2.6) of zinnwaldite ore with *lithium content* (3.1.2) expressed as percentage of lithium oxide

Note 1 to entry: *Zinnwaldite concentrate* contains typically 2.5% - 4.4% lithium oxide.

3.2.6.4
petalite concentrate
concentrate (3.2.6) of petalite ore with *lithium content* (3.1.2) expressed as percentage of lithium oxide

Note 1 to entry: *Petalite concentrate* contains typically 4.00% - 4.75% lithium oxide.

3.2.6.5
lithium brine concentrate
concentrate (3.2.6) of solution from naturally occurring lithium brines

EXAMPLE 1: *Lithium brine concentrate* in Chile typically contains about 6% *lithium* (3.1.1).

EXAMPLE 2: *Lithium brine concentrates* in China obtained in a beneficiation process reaches a concentration greater than 0.1% *lithium* (3.1.1).

3.3 Terms related to lithium compounds and lithium alloys

3.3.1
lithium metal
soft, silvery white or silvery grey and lustrous metal

Note 1 to entry: *Lithium metal*(3.3.1) is produced by electrolysis of a fused mixture of lithium chloride and potassium chloride.

Note 2 to entry: *Lithium metal*(3.3.1) can be drawn into wire and rolled into sheets, is softer than lead but harder than the other alkali metals.

3.3.1.1
crude lithium metal
lithium metal (3.3.1) directly produced by the electrolysis of lithium chloride

Note 1 to entry: *Crude lithium metal*(3.3.1.1) has a silvery white or silvery grey in appearance, usually in the form of ingots.

Note 2 to entry: *Crude lithium metal*(3.3.1.1)is easy to react with oxygen and nitrogen in the air and turn dark, and react violently with water and oxidiser, etc. Mineral oil is usually used for protection in the production process.

3.3.1.1.1
technical grade lithium metal
crude lithium metal (3.3.1.1) purified

Note 1 to entry: *Technical grade lithium meta*l contains typically 96,5% - 99,9% *lithium metal(3.3.1).*

Note 2 to entry: *Technical grade lithium metal* is silver-white in appearance, and can react with oxidisers, water, alcohols, halogenated hydrocarbons, etc. Technical grade lithium metal has strong catalytic activity and is mainly used in industrial catalysis and chemical synthesis.

3.3.1.1.2
battery grade lithium metal
crude lithium metal (3.3.1.1) purified

Note 1 to entry: *Battery grade lithium metal* contains typically more than 99,9% *lithium metal(3.3.1).*

Note 2 to entry: *Battery grade lithium metal* has the most negative electrode potential, and is the ideal battery material.

Note 3 to entry: *Battery grade lithium metal* has a silvery white in appearance, reacts rapidly with oxygen and nitrogen in air, and reacts violently with water and oxidiser.

3.3.1.2
lithium ingot
lithium metal (3.3.1) in the shape of cylinder or nearly cylindrical

Note 1 to entry: *Lithium ingot* has a typically diameter greater than 60 mm and the length less than 600 mm.

3.3.1.3
lithium foil
lithium metal (3.3.1) in the shape of ribbon

Note 1 to entry: Ultra-wide lithium foil, lithium foil with its width greater than 150 mm.

Note 2 to entry: Ultra-thin lithium foil, lithium foil with its thickness less than 0,1mm.

3.3.1.4
lithium particles
lithium metal (3.3.1) in the shape of small cylinders or nearly small cylinders

Note 1 to entry: *Lithium particles* typically has a diameter less than 20 mm, and a length less than 30 mm.

3.3.1.5
lithium chip
lithium metal (3.3.1) in the shape of rectangle or near rectangle

3.3.1.6
lithium discs
lithium metal (3.3.1) in the shape of disc

3.3.1.7
lithium rods
lithium metal (3.3.1) in the shape of cylinder or nearly a small cylinder

Note 1 to entry: *Lithium rods* typically has a diameter less than 30 mm, and a length less than 30 mm.

3.3.1.8
lithium plates
lithium metal (3.3.1) in the shape of a rectangle or near rectangle

3.3.1.9
lithium powder
lithium metal (3.3.1) in the form of small powdered particles

Note 1 to entry: *Lithium powder* has an appearance of brown or tan colour.

Note 2 to entry: *Lithium powder* has a passivated layer or mineral oil on the exterior.

3.3.2
lithium compound
Compound of *lithium* (3.1.1)

3.3.2.1
lithium oxide
oxide of lithium, with molecular formula Li_2O

Note 1 to entry: *Lithium oxide* is a white solid and is produced by *lithium metal*(3.3.1) burning in the presence of oxygen.

3.3.2.2
lithium sulphate
compound containing two lithium ions and a sulphate ion, with molecular formula of Li_2SO_4

3.3.2.3
lithium carbonate
compound containing two lithium ions and a carbonate ion, with molecular formula of Li_2CO_3

3.3.2.3.1
technical grade lithium carbonate
lithium carbonate (3.3.2.3) mainly used for industrial applications and as feedstock for production of battery grade lithium salts

Note 1 to entry: *Technical grade lithium carbonate* typically contains not less than 98,0% of Li_2CO_3.

3.3.2.3.2
battery grade lithium carbonate
lithium carbonate (3.3.2.3) mainly used for battery materials production

Note 1 to entry: *Battery grade lithium carbonate* typically contains not less than 98,5% of Li_2CO_3.

3.3.2.3.3
high purity lithium carbonate
lithium carbonate (3.3.2.3) mainly used for battery materials production or other high purity lithium compound production

Note 1 to entry: High purity *grade lithium carbonate* typically contains not less than 99,99% of Li_2CO_3.

3.3.2.4
lithium hydroxide
compound containing one lithium ion and a hydroxide ion, molecular formula LiOH. It is an alkali metal hydroxide

Note 1 to entry: *Lithium hydroxide* is a highly alkaline inorganic compound that can absorb CO_2 in the air (From ISO 22252-2020).

Note 2 to entry: *Lithium hydroxide* solution neutralises acids exothermically to form salts and water.

3.3.2.4.1
lithium hydroxide monohydrate
compound containing one lithium ion, a hydroxide ion and one molecule of water, with molecular formula of $LiOH \cdot H_2O$

3.3.2.4.1.1
technical grade lithium hydroxide monohydrate
lithium hydroxide monohydrate (3.3.2.4.1) mainly used for industrial applications (e.g. greases, lubricants), or feedstock for battery grade lithium salt production

Note 1 to entry: *Technical grade lithium hydroxide monohydrate typically contains not less than* 56,5% LiOH.

3.3.2.4.1.2
battery grade lithium hydroxide monohydrate
lithium hydroxide monohydrate (3.3.2.4.1) mainly used for battery materials production.

Note 1 to entry: *Battery grade lithium hydroxide monohydrate* typically contains 56,5% - 57,5% LiOH.

3.3.2.4.1.3
micronised battery grade lithium hydroxide monohydrate
battery grade lithium hydroxide monohydrate (3.3.2.4.1.2) which has been micronised

Note 1 to entry: Particle size distribution of m*icronised battery grade lithium hydroxide monohydrate* typically meets 3 μm ≤ D_{50} ≤ 20 μm.

3.3.2.4.2
lithium hydroxide anhydrous
lithium hydroxide monohydrate (3.3.2.4.1) dehydrated

3.3.2.5
lithium chloride
compound containing one lithium ion and one chloride ion, with molecular formula of LiCl

3.3.2.6
lithium phosphate
compound containing three lithium ions and a phosphate ion, with molecular formula of Li_3PO_4

3.3.2.7
lithium dihydrogen phosphate
compound containing one lithium ion and a dihydrogen phosphate ion, with molecular formula of LiH_2PO_4

3.3.2.7.1
battery grade lithium dihydrogen phosphate
lithium dihydrogen phosphate (3.3.2.7) mainly used for battery materials production

Note 1 to entry: *Battery grade lithium dihydrogen phosphate* typically contains more than 99,5% LiH_2PO_4.

3.3.2.8
lithium fluoride
compound containing lithium ion and a fluorine ion, with molecular formula of LiF

Note 1 to entry: It is a diffracting crystal featuring 2d spacing of 0,402 8 nm used in WDS for dispersion of X-rays (from ISO 19463:2018).

3.3.2.9
lithium oxalate
compound containing two lithium ions and an oxalate ion, with molecular formula of $Li_2C_2O_4$

3.3.2.10
lithium hydride
compound containing a lithium ion and a hydrogen ion, with molecular formula of LiH

Note 1 to entry: Blue-grey translucent crystals or powder, easily deliquescent.

Note 2 to entry: Flammable, the powder can catch fire in contact with moist air and reacts violently with water.

3.3.2.11
lithium amide
compound containing one element of lithium, one element of nitrogen and two elements of hydrogen, with molecular formula of $LiNH_2$

Note 1 to entry: White lustrous crystals or powder, with the odour of ammonia, and strongly decomposes when it meets water.

3.3.2.12
lithium sulphide
compound containing two elements of lithium and one element of sulphur, with molecular formula of Li_2S

Note 1 to entry: White or yellow crystal, easily soluble in water, easily absorbs water vapor in air and hydrolysed.

3.3.2.13
lithium tetraborate
with chemical formula of $Li_2O\cdot 2B_2O_3$ or $Li_2B_4O_7$

3.3.2.14
lithium metaborate
with chemical formulaof $Li_2O\cdot B_2O_3$ or $LiBO_2$

3.3.3
lithium alloy
intermetallic compounds with definite phase compositions

Note 1 to entry: *Lithium alloys* can be compounds of various metals like lead, copper, silver, magnesium, silicon and aluminium .

3.3.3.1
lithium-aluminium alloy
lithium alloys (3.3.3.1) is created by adding aluminium into molten *lithium metal* (3.3.1)

Note 1 to entry: *Lithium-aluminum alloy* is obtained by mixing, cooling and solidifying.

Note 2 to entry: The appearance of *lithium-aluminum alloy* is generally silvery white, and the aluminium content is generally less than 50%.

Note 3 to entry: The chemical properties of *lithium-aluminum alloy* mainly reflect the chemical properties of lithium, and slowly reflect the chemical properties of aluminium as the aluminium content increases.

Note 4 to entry: *Lithium-aluminium alloy* processed into ingots is called lithium-aluminium alloy ingots, and processed into strips is called lithium-aluminium alloy strips.

3.3.3.2
aluminium-lithium alloy
lithium alloys (3.3.3.1) is created by adding *lithium metal* (3.3.1) into molten aluminium.

Note 1 to entry: *Aluminium-lithium alloy* is obtained by mixing, cooling and solidifying.

Note 2 to entry: The appearance of *aluminium-lithium alloy* is silvery grey, and the aluminium content is greater than 50%.

Note 3 to entry: The chemical properties of *aluminium-lithium alloy* mainly reflect the chemical properties of aluminium, and as the aluminium content increases, the more obvious the chemical properties of aluminium are reflected.

Note 4 to entry: *Aluminium-lithium alloy* processed into powder is called aluminium-lithium alloy powder, processed into ingot is called aluminium-lithium alloy ingot, etc.

3.3.3.3
lithium-magnesium alloy
lithium alloys (3.3.3.1) is created by adding magnesium into molten lithium after mixing, cooling and solidifying

Note 1 to entry: *Lithium-magnesium alloy* is obtained by mixing, cooling and solidifying.

Note 2 to entry: Magnesium content of l*ithium-magnesium alloy* is generally less than 50%.

Note 3 to entry: The chemical properties of l*ithium-magnesium alloy* mainly reflect the chemical properties of lithium, with the increase of lithium content, reflecting the more obvious lithium chemical properties.

Note 4 to entry: L*ithium-magnesium alloy* processed into ingots is called lithium-magnesium alloy ingots, processed into strips is called lithium-magnesium alloy strips, etc.

3.3.3.4
lithium-silicon alloy
lithium alloys (3.3.3.1) is created by adding silicon to molten lithium

Note 1 to entry: *Lithium-silicon alloy* is obtained by mixing, cooling and solidifying.

Note 2 to entry: *Lithium-silicon alloy* has a silvery grey in appearance with metallic lustre, easily oxidized and discoloured in air, reacts violently with water.

Note 3 to entry: *Lithium-silicon alloy* is usually processed into a powder called lithium-silicon alloy powder.

3.3.3.5
lithium-boron alloy
lithium alloys (3.3.3.1) is created by adding boron into molten lithium

Note 1 to entry: *Lithium-boron alloy* is obtained by mixing, cooling and solidifying.

Note 2 to entry: *Lithium-boron alloy* has a silvery in appearance with metallic lustre, easily oxidised and discoloured in air, and reacts violently with water.

Note 3 to entry: *Lithium-boron alloy* processed into ingots is called lithium-boron alloy ingots, processed into strips is called lithium-boron alloy strips, and processed into sheets is called lithium-boron alloy sheets.

3.4 Terms related to cathode material

3.4.1
lithium cobalt oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, cobalt and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and the chemical formulas can generally be expressed as $LiCoO_2$

3.4.2
lithium nickel oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, nickel and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and their chemical formulas can generally be expressed as $LiNiO_2$

3.4.3
lithium manganese oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, manganese and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and their chemical formulas can generally be expressed as $LiMnO_2$

3.4.4
lithium nickel manganese oxide
cathode materials for lithium-ion batteries mainly contain elements, such as lithium, nickel, manganese and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and the chemical formulas can generally be expressed as $LiNi_{1-x}Mn_xO_2$

3.4.5
lithium nickel cobalt oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, nickel, cobalt and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and the chemical formulas can generally be expressed as $LiNi_{1-x}Co_xO_2$

3.4.6
lithium manganese cobalt oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, manganese, cobalt and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and their chemical formulas can generally be expressed as $LiMn_{1-x}Co_xO_2$

3.4.7
lithium nickel cobalt manganese oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, nickel, cobalt, manganese and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and the chemical formulas can generally be expressed as $LiNi_{1-x-y}Co_xMn_yO_2$

3.4.8
lithium nickel cobalt aluminium oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, nickel, cobalt, aluminum and oxygen, with α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group, and the chemical formulas can generally be expressed as LiNi1-x-yCoxAl$_y$O$_2$

3.4.9
lithium rich layered oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, manganese, nickel, cobalt and oxygen, which are the solid solution materials composed of Li_2MnO_3 (monoclinic system and C2/m space group) and $LiNi_{1-x-y}Co_xMn_yO_2$ (α-$NaFeO_2$ type, hexagonal crystal system, $R\bar{3}m$ space group). The chemical formulas can generally be expressed as $Li_{1+a}(Mn_{1-x-y}Ni_xCo_y)_{1-a}O_2$

3.4.10
spinel lithium nickel manganese oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, manganese, nickel and oxygen, with spinel type, cubic crystal system, $Fd\bar{3}m$ or $P4_332$ space group, and the chemical formulas can generally be expressed as $LiNi_{0.5}Mn_{1.5}O_4$

3.4.11
lithium manganese oxide
cathode materials for lithium-ion batteries mainly contain elements such as lithium, manganese and oxygen, with spinel type, cubic crystal system, $Fd\bar{3}m$ space group, and the chemical formulas can generally be expressed as $LiMn_2O_4$

3.4.12
lithium iron phosphate
cathode materials for lithium-ion batteries mainly contain element, such as lithium, iron, phosphorus and oxygen, with olivine type, orthorhombic crystal system, Pnma space group, and the chemical formulas can generally be expressed as $LiFePO_4$

3.4.13
lithium manganese iron phosphate
cathode materials for lithium-ion batteries mainly contain elements, such as lithium, manganese, iron, phosphorus, oxygen, with olivine type, orthorhombic crystal system, Pnma space group, and the chemical formulas can generally be expressed as $LiMn_{1-x}Fe_xPO_4$

3.4.14
cathode material precursor
intermediates for the production of lithium cathode materials, usually are hydroxide or oxide, which contain another metallic ion, such as iron, cobalt, nickel or manganese, etc

3.5 Terms related to lithium product processing

3.5.1 processing of lithium minerals concentrate

3.5.1.1
gravity separation
process method to separate minerals according to the different specific gravity of minerals and the different settling velocity in the medium

3.5.1.2
flotation
process method to separate minerals by flotation agent according to different physical and chemical properties of mineral surface

3.5.2 Processing of lithium salts

3.5.2.1
transforming roasting
roasting process where the crystal form of spodumene concentrate is transformed from α-spodumene to β-spodumene at high temperature

3.5.2.2
sulphating roasting, acidifying roasting
process where the lithium of β-spodumene is transformed to a lithium compound which is easily dissolved in water, by blended roasting of β-spodumene and concentrated sulfuric acid

3.5.2.3
leaching
process of dissolving the lithium in materials with water as a solvent, and the lithium will be transferred into liquid phase

3.5.2.4
impurity removing
process of purifying the materials and meeting the products quality requirements through physical and chemical methods to remove impurities or suspended solids. In the production process of lithium salts, physical methods include removal of suspended solids by polishing filter, removal of magnetic impurities by magnetic strainers, and chemical methods include acid-base neutralization, pH value adjustment, alkalisation purification, and ion exchange.

3.5.2.5
carbonation
process where the lithium hydroxide solution is transformed into lithium carbonate through inlet carbon dioxide or chemical treatment with a carbonate source, also called carbon sedimentation.

3.5.2.6
bicarbonation
process where the lithium carbonate slurry is transformed to lithium hydrogen carbonate by inlet carbon dioxide

3.5.2.7
evaporation concentration
process of heating the refined lithium salt solution so that some water evaporates and the concentration of lithium salt increases

3.5.2.8
sodium precipitation by freezing
process of precipitation of sodium sulphate (Na_2SO_4) from the blending solution at low temperature

Note 1 to entry: The low temperature condition is generally controlled at -5 ℃~-7 ℃.

3.5.2.9
redissolution
process of re-dissolving the product of primary crystallisation with water and evaporating it again to obtain the product

3.5.2.10
evaporative crystallization
evaporation of the solvent causes the solution to change from unsaturated to saturated, and as the evaporation continues, the excess solute is precipitated as crystals

3.5.2.11
centrifugal separation
operation of using centrifugal force to achieve the separation of lithium compound crystals from the mother liquor

3.5.2.12
drying
operation of evaporating the water away from the wet lithium material by heating

3.5.2.13
crushing
operation of crushing large pieces of material into smaller particles or powders

3.5.3 Processing of lithium metal

3.5.3.1
molten salt electrolysis
process of preparing *crude lithium metal*(3.3.1.1) by electrochemical method by molten DC electrolysis of lithium chloride

Note 1 to entry: To lower the melting point of lithium chloride, potassium chloride will be added to form a two-component molten salt system at the time of production.

3.5.3.2
cryogenic vacuum distillation
process of separation is achieved based on the difference in saturated vapour pressure of lithium and other metal impurities

Note 1 to entry: Low temperature vacuum distillation temperature is generally less than 600 ℃.

3.5.3.3
insulation settlement
crude lithium metal(3.3.1.1) is melted and maintained at a certain temperature to achieve separation by using the same density of different materials.

3.5.3.4
filtration
separating liquids and insoluble solids using special devices by taking advantage of the difference in solubility of substances

3.5.3.5
squeezing
pressure processing method in which a blank placed in a concave die is pressurized with a punch or a convex die to produce a plastic flow to obtain a part corresponding to the shape of the die's hole or concave/convex die.

3.5.3.6
coiling
process method that uses a motor and a tension control system to reel the strip into a coil.

3.5.3.7
ball milling
crushing method in which a certain number of spherical grinding media are loaded into the cylinder to rotate the material at high speed

Note 1 to entry: Lithium alloy ball milling generally refers to dry ball milling.

3.6 Terms related to quality characteristic of lithium products

3.6.1
magnetic impurity (Metallic Magnetic Impurity (MMI))
material which can be attracted by ferromagnet with the magnetic induction intensity of 6000Gs directly or indirectly

Note 1 to entry: *Magnetic impurity* mainly refers to total content of the transitional elements - iron, chromium, nickel, zinc and their alloys with magnetic substances.

3.6.2
metal particles quantity
quantity of metal impurities with defined size determined by cleanliness testing instrument

3.6.3
cationic impurities
cationic impurities of alkali metals, alkaline earth metals and transitions metals typically determined by ICP analysis

3.6.4
anionic impurities
anionic impurities like sulphate, nitrate, chloride, bromide, fluoride, etc

3.6.5
acid insoluble
insoluble substances in hydrochloric acid

3.6.6
water insoluble
insoluble substances in water

3.6.7
moisture content
water analysis typically determined by gravimetry or Karl-Fischer titration

3.6.8
particle size distribution
size distribution of powder particles

Note 1 to entry: *Particle size distribution* for micrometer sized particles is mainly determined by laser diffraction.

Note 2 to entry: *Particle size distribution* typically reported in volume distribution which is noted as D_{min}, Dv_{10}, Dv_{50}, Dv_{90}, Dv_{99}, D_{max} values or sieve analysis.

3.7 Terms related to quality characteristics of lithium cathode materials

3.7.1 General terms of lithium cathode materials

3.7.1.1
impurity elements
elements, introduced by raw materials or transformation process

Note 1 to entry: Impurity elements produce non-desired effects on the electrochemical performance of cathode material.

Note 2 to entry: Such elements are Na, Ca, K, Cu, Zn, Fe, etc.

Note 3 to entry: Metallic impurity elements, such as substances, alloys or compounds containing Fe, Cr, Ni, Zn and Cu, which can affect the safety of lithium-ion batteries.

3.7.1.2
residual alkali content
excessive soluble lithium compounds on the surface of cathode materials, having non-desired effects on the processability, electrochemical performance and safety of lithium-ion batteries

3.7.1.3
apparent density
bulk density of a powder freely filled in a standard container under specified conditions. It is the mass per unit volume of the powder when loosely packed

3.7.1.4
tap density
mass per unit volume of powder in a container that has been processed under specified conditions

3.7.1.5
specific surface
total area of material per unit mass

3.7.2 Electrochemical characteristics of lithium cathode materials

3.7.2.1
specific capacity
electrochemical capacity per unit mass of active substance when charging and discharging under specified conditions, specific capacity`s unit of measurement is milliampere hours per gram of active substance

3.7.2.2
plateau capacity ratio
percentage of the discharge plateau capacity of the active substance under specified conditions to the discharge capacity at discharge to the end-of-discharge voltage

3.7.2.3
plateau capacity retention
percentage of the discharge plateau capacity of the active substance at a specified number of cycles to the first discharge plateau capacity

3.7.2.4
cycle life
number of charge-discharge cycles of the active substance under specified conditions, when the ratio of discharge capacity to the discharge capacity of the first cycle reaches the specified value

3.7.2.5
volume resistivity
resistance of the material to current per unit volume

3.7.2.6
coulombic efficiency
ratio of the discharging capacity to the charging capacity of the active substance under specified conditions

3.7.2.7
rate performance
performance of active substances in battery under large current during charge or discharge, usually indicated by the ratio of the specific capacity under large current to the one under small current

3.7.2.8
cycle performance
performance of active substances in battery after certain cycles of charge and discharge under certain conditions, usually indicated by the ratio of capacity after cycling to the capacity before cycling

3.7.2.9
storage performance

performance of charged active substances in battery after storage under certain temperature(typically 60℃) for a period of time, usually indicated by the ratio of the capacity after cycling to the capacity before cycling

3.7.2.10
high-temperature cycle performance
performance of active substances in battery under relatively high temperature (typically 45℃) after a certain number of cycles of charge and discharge, usually indicated by the ratio of the capacity after cycling to the capacity before cycling

3.7.2.11
low-temperature discharge performance
performance of active substances in battery under relatively low temperature (typically −20℃) , usually indicated by the charge and discharge capacity and cycling performance under low temperature compared to the performance under room temperature

3.8 Terms related to scrap recycling and utilization

3.8.1
wet process recycling
process of separating, enriching and extracting metals by using leaching agents to dissolve valuable metal components of waste battery chemicals in solution or by precipitating them in a new solid phase

3.8.2
heat process recycling
process of extracting or refining metal alloys from waste battery chemicals at high temperatures and the rendering harmless of some of the waste chemicals

3.8.3
heat treatment
process of decomposition of disassembled waste battery chemicals such as electrolyte, diaphragm, binder, etc. by heat under reaction pressure below atmospheric pressure

3.8.4
primary combustion
process of primary combustion of waste battery chemicals to turn organic materials such as electrolyte and diaphragm into inorganic gases such as water and carbon dioxide

3.8.5
secondary combustion
process that continues to transform the organic materials which incompletely combusted during the primary combustion into inorganic gases

3.8.6
sorting
process of separation and enrichment of metals, metal compounds, graphite, etc. by crushed particulate matter under the action of magnetic force, gravity, centrifugal force, wind and other dynamics, according to the differences in magnetism, density, suspension speed, etc

3.8.7
sorting recognition rate
fraction of the mass of identified target components in the sorting process of waste battery chemicals to the mass of target components in waste battery chemicals

3.8.8
dust removal
process of separating solid particles such as nickel, cobalt and manganese from the production dust and capturing and recovering them in the process of chemical treatment and disposal of waste batteries

3.8.9
dust removal efficiency
fraction of the mass of dust captured by the dust collector per unit time of the mass of dust fed to the dust collector during the dust removal process of waste battery chemicals.

3.8.10
leaching
process of dissolving metals from waste battery chemicals after removing electrolyte, diaphragm, binder, etc. with acid or alkaline substances

3.8.11
leaching rate
fraction of the mass of the target metal leached during the treatment of waste battery chemicals to the mass of the target metal contained in the waste battery chemicals

3.8.12
loss rate
fraction of the lost mass of important elements to the mass of the corresponding elements contained in the waste battery chemicals should be recovered during the treatment of the waste battery chemicals.

3.8.13
recycling rate
fraction of the mass of the target metal recycled in the waste battery chemical treatment process to the mass of the target metal contained in the waste battery chemical

3.8.14
absorption
process of absorbing one - or several gases (e.g., HF, Nitrogen oxides, etc.) from the mixed waste gases generated by the thermal decomposition, leaching, etc. of waste battery chemicals with a solution or solvent to separate them from the mixed waste gases

3.8.15
adsorption
process of adsorption of mixed waste gases generated from waste battery chemicals during thermal decomposition, leaching, etc., by a porous solid adsorbent material with mixed organic gases

3.8.16
elemental recycling rate
sum of the mass of one target element recovered during the treatment process as a percentage of the sum of the mass of the target elements contained in the waste battery chemical

3.8.17
integrated recycling rate
sum of the mass of multiple target elements recovered during the treatment process as a percentage of the sum of the mass of target elements contained in the waste battery chemicals

Annex A
(Informative)

Lithium minerals details

Mineralogy	Theoretical Formula	Theoretical Major Oxides content %		
		Li_2O	Cs_2O	Rb_2O
Spodumene	$LiAl(Si_2O_6)$	5.8-8.1	0.002-0.007	0.002-0.008
Lepidolite (Lithia mica, Lithionite)	$K_2(Li,Al)_{5\text{-}6}[Si_{6\text{-}7}Al_{2\text{-}1}O_{20}](OH,F)_4$	3.2-6.45	1.51-3.80	0.02-1.082
Amblygonite (Hebronite)	$LiAl[PO_4]F$	7.1-10.1	/	/
Montebrasite (Mnotebrazit)	$LiAlPO_4(OH,F)$	9.12	/	/
Petalite	$Li[AlSi_4O_{10}]$	2.9-4.9	/	/
Zinnwaldite (Lepidomelane)	$K_2(Li,Al)[Si_4O_{14}](F,OH)_2$	1.1-5	/	/
Eucryptite	$Al[AlSiO_4]$	11.88	/	/
Cryolithionite	$Na_3Li_3Al_2F_{12}$	5.6	/	/
Rhodizite	$(K,Cs)_2(Al,Li)_8[Be_3B_{10}O_{27}]$	7.81	/	/
Bikitaite	$LiAl[SiO_3]_2H_2O$	6.55	/	/
Polylithionite	$K_2(Li,Al)[Si_4O_{14}](F,OH)_2$	7.68	/	/
Liberite	$Li_2[BeSiO_4]$	23.43	/	/
Triphylite	$Li(Fe,Mn)[PO_4]$	6.83	/	/
Lithiophilite	$Li(Mn,Fe)[PO_4]$	6.06-10	/	/
Lithiophosphate	$Li_3[PO_4]$	37.07	/	/
Tancoite	LiNa2HAl(PO4)2(OH)	5.23	/	/
Lithian-Moscovite	K(Al,Li)2(Al,Si)4O10(OH,F)2	0.86-3.97	0.21-0.79	1.63-3.46