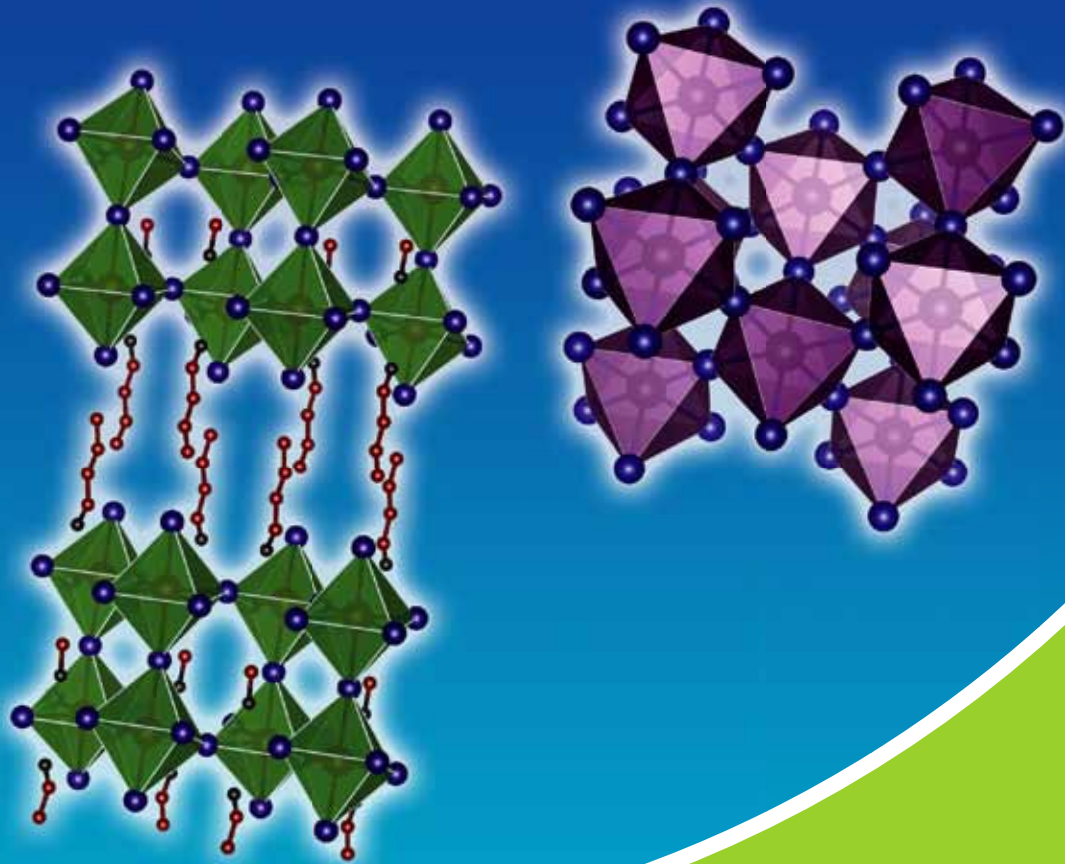


有机-无机钙钛矿前体

Organic-Inorganic Perovskite Precursors



有机鎊盐

卤化铅

其它铅化合物

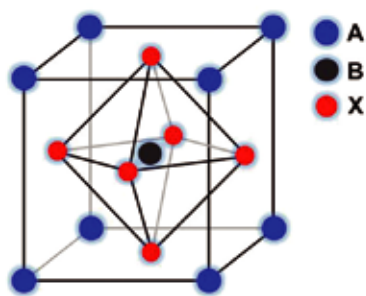
卤化铯

卤化铋

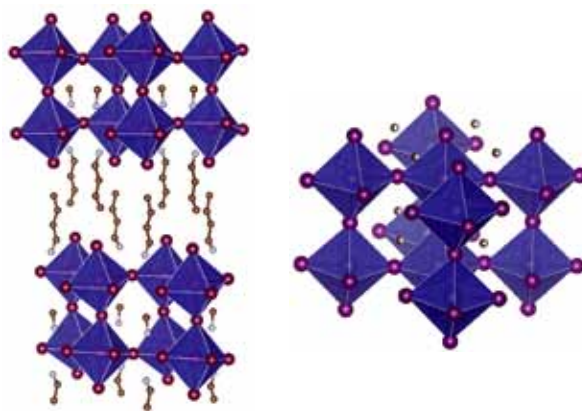
卤化锡

有机-无机钙钛矿前体

“钙钛矿”源于钛酸钙(CaTiO_3)的矿物名，它是一类分子通式为 ABX_3 的化合物，其中，A代表二价金属离子，B代表四价金属离子。立方相或正交相的钙钛矿呈现出铁电性，比如，钛酸钡(BaTiO_3)就是一种铁电或压电材料¹⁾。所有钙钛矿化合物中，都含有以铜氧化物为结构单元的高温超导氧化物²⁾。这些钙钛矿化合物由金属离子和氧原子组成，通过物理方法制造(如烧结法)³⁾。对金属离子进行修饰，以及改变金属离子的比例，可以控制钙钛矿的物理性质。除了氧化物型钙钛矿，卤化物型钙钛矿也十分常见。



另一方面，可以用有机铵替代A位上的阳离子。这样即用化学方法得到了一种钙钛矿化合物。这种钙钛矿化合物含有有机组分，因此被称为“有机-无机钙钛矿化合物”。其中的金属离子通常为锡或铅^{4,5)}。此类钙钛矿化合物的分子通式为 $[(\text{RNH}_3)_m\text{MX}_n]$ ，通过对金属(M)、卤素(X)以及有机基团(R)的修饰，可以对其物理性质进行精确控制。其中，锡钙钛矿的导电性相对较好⁶⁾，而铅钙钛矿的光学特性则相对更好⁷⁾。另外，对卤素进行化学修饰还可以控制带隙⁸⁾。不同的卤化镧盐、金属卤化物，及其混合的比例，都可以改变卤素的构成比例。有机基团(R)通常为甲基、长链烷基、苯基、苄基、苯乙基等。有机基团的不同控制着钙钛矿化合物的结构。例如，R=甲基的钙钛矿化合物 $[(\text{MeNH}_3)\text{MX}_3]$ ，具有三维立方结构⁹⁾。而 $\text{R}=\text{C}_n\text{H}_{2n+1}$ ($n \geq 2$)的钙钛矿化合物，呈二维层状结构，并且烷基的长度可以改变层间的距离¹⁰⁾。



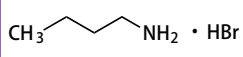
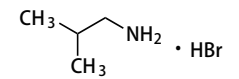
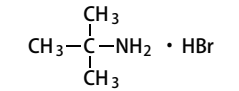
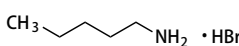
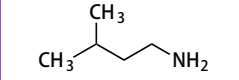
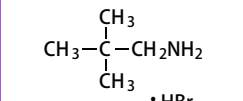

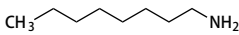
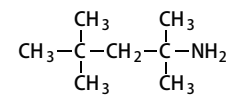
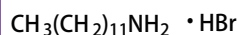
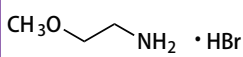
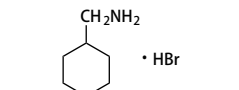
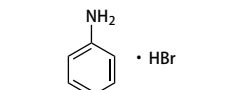
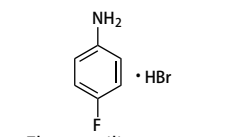
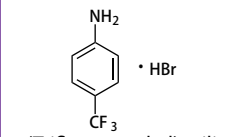
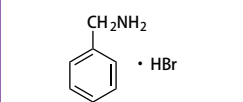
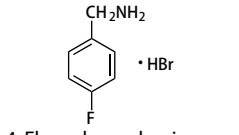
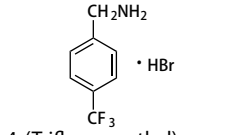
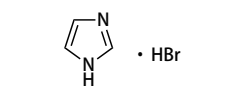
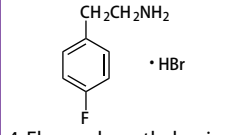
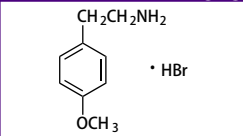
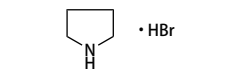
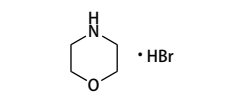
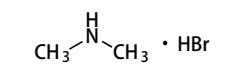
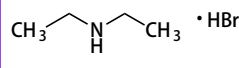
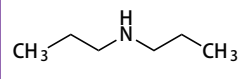
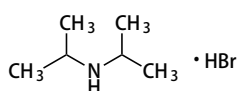
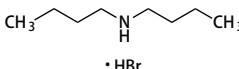
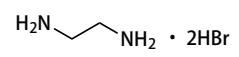
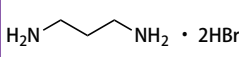
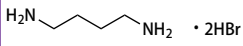
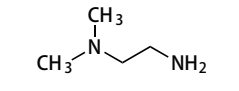
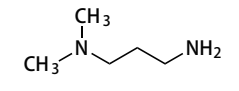
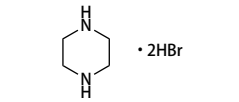
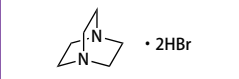
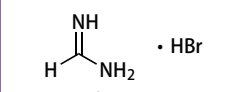
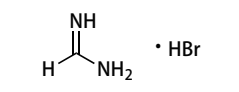
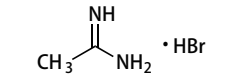
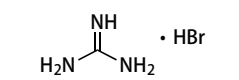
钙钛矿太阳能电池是有机-无机钙钛矿的应用之一¹¹⁻¹⁵⁾，其可以利用三维立方钙钛矿 $[(\text{MeNH}_3)\text{MX}_3]$ 制备。钙钛矿太阳能电池的研究中也包括了甲脒阳离子¹⁶⁾和铯阳离子¹⁷⁾对A位的掺杂效应。近来，对钙钛矿太阳能电池的研究引起了众多关注。这类太阳能电池的光电转化效率高于其它的有机太阳能电池(OPV)和染料敏化太阳能电池(DSSC)，并且利用溶液法即可低成本制造。

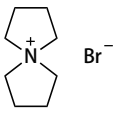
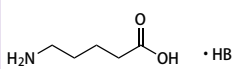
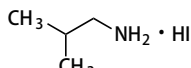
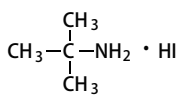
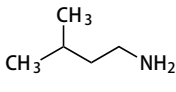
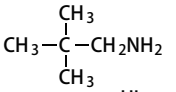
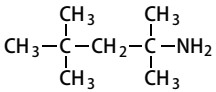



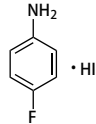

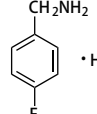
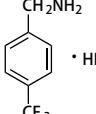
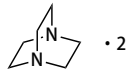
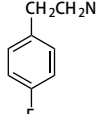
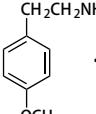
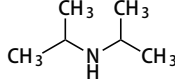
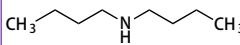


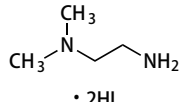
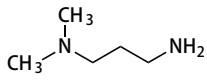
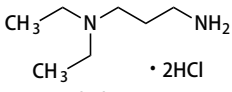
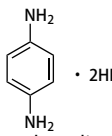

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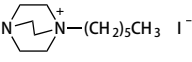
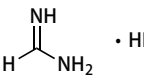
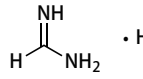
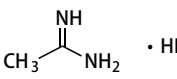
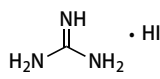
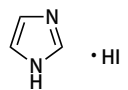
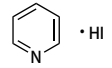
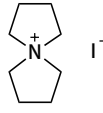
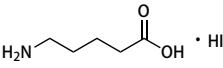
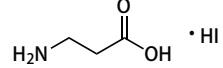
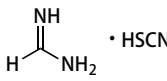
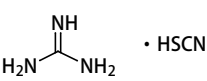
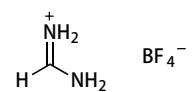
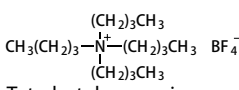
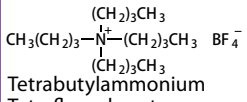
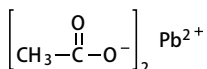
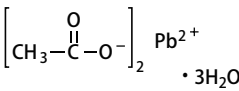
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有机鎏盐 Organic Onium Salts		氯化盐 Chloride Salts		M0138 25g 500g	E0205 25g 500g
F1250 1g 5g	P0522 25g	I0166 25g 100g 500g	B0710 25g 500g	I0096 25g 500g	
2-Fluoroethylamine Hydrochloride CAS RN: 460-08-2	Propylamine Hydrochloride CAS RN: 556-53-6	Isopropylamine Hydrochloride CAS RN: 15572-56-2	Butylamine Hydrochloride CAS RN: 3858-78-4	Isobutylamine Hydrochloride CAS RN: 5041-09-8	
I0083 1g 5g	P2736 1g 5g	O0484 1g 5g	T3784 1g 5g	F1271 5g 25g	
Isopentylamine Hydrochloride CAS RN: 541-23-1	Pentylamine Hydrochloride CAS RN: 142-65-4	n-Octylamine Hydrochloride CAS RN: 142-95-0	tert-Octylamine Hydrochloride CAS RN: 58618-91-0	4-Fluoroaniline Hydrochloride CAS RN: 2146-07-8	
T3833 1g 5g	B0407 25g 100g 500g	F1255 1g 5g	T3836 1g 5g		
4-(Trifluoromethyl)aniline Hydrochloride CAS RN: 90774-69-9	Benzylamine Hydrochloride CAS RN: 3287-99-8	4-Fluorobenzylamine Hydrochloride CAS RN: 659-41-6	4-(Trifluoromethyl)benzylamine Hydrochloride CAS RN: 3047-99-2		
F1256 1g 5g	M3284 5g 25g	D0468 25g 500g	D5253 1g 5g	D5617 1g 5g	
2-(4-Fluorophenyl)ethylamine Hydrochloride CAS RN: 459-19-8	Morpholine Hydrochloride CAS RN: 10024-89-2	Diethylamine Hydrochloride CAS RN: 660-68-4	1,3-Diaminopropane Dihydrochloride (Low water content) CAS RN: 10517-44-9	N,N-Dimethyl-1,3-propanediamine Dihydrochloride CAS RN: 52198-63-7	
D5860 5g	D5861 5g	A3393 5g	P2491 1g 5g	D5251 1g 5g	
N,N-Diethylethylenediamine Dihydrochloride CAS RN: 52198-62-6	3-(Dimethylamino)propylamine Dihydroiodide CAS RN: 99310-71-1	2-(1-Pyrrolidinyl)ethanamine Dihydrochloride CAS RN: 65592-36-1	Piperazine Dihydrochloride CAS RN: 142-64-3	1,4-Diazabicyclo[2.2.2]octane Dihydrochloride CAS RN: 49563-87-3	
F0103 5g 25g	A0008 25g 500g	G0162 25g 500g	A3092 1g 5g	A0436 1g 5g	
Formamidine Hydrochloride CAS RN: 6313-33-3	Acetamidine Hydrochloride CAS RN: 124-42-5	Guanidine Hydrochloride CAS RN: 50-01-1	5-Azoniaspiro[4.4]nonane Chloride CAS RN: 98997-63-8	5-Aminovaleric Acid Hydrochloride (Low water content) CAS RN: 627-95-2	
	M2589 1g 5g 25g	E0056 25g 500g	P2502 1g 5g	I1041 1g 5g	
	Methylamine Hydrobromide (Low water content) CAS RN: 6876-37-5	Ethylamine Hydrobromide CAS RN: 593-55-5	Propylamine Hydrobromide CAS RN: 4905-83-3	Isopropylamine Hydrobromide CAS RN: 29552-58-7	

溴化盐
Bromide Salts

B5186 1g 5g  Butylamine Hydrobromide CAS RN: 15567-09-6	I1007 1g 5g  Isobutylamine Hydrobromide CAS RN: 74098-36-5	B5187 1g 5g  tert-Butylamine Hydrobromide CAS RN: 60469-70-7	P2739 1g 5g  Pentylamine Hydrobromide CAS RN: 7334-94-3	I1094 1g 5g  Isopentylamine Hydrobromide
N1156 1g 5g  Neopentylamine Hydrobromide	H1678 1g 5g  Hexylamine Hydrobromide CAS RN: 7334-95-4	O0442 1g 5g  n-Octylamine Hydrobromide CAS RN: 14846-47-0	T3783 1g 5g  tert-Octylamine Hydrobromide CAS RN: 1093859-61-0	D5537 1g 5g  Dodecylamine Hydrobromide CAS RN: 26204-55-7
M3287 1g 5g  2-Methoxyethylamine Hydrobromide CAS RN: 663941-77-3	C3531 1g 5g  Cyclohexanemethylamine Hydrobromide	A2985 1g 5g  Aniline Hydrobromide CAS RN: 542-11-0	F1272 5g 25g  4-Fluoroaniline Hydrobromide CAS RN: 85734-18-5	T3834 1g 5g  4-(Trifluoromethyl)aniline Hydrobromide CAS RN: 148819-81-2
B5185 1g 5g  Benzylamine Hydrobromide CAS RN: 37488-40-7	F1227 1g 5g  4-Fluorobenzylamine Hydrobromide CAS RN: 2270172-94-4	T3837 1g 5g  4-(Trifluoromethyl)benzylamine Hydrobromide	I1006 1g 5g  Imidazole Hydrobromide (Low water content) CAS RN: 101023-55-6	F1229 1g 5g  4-Fluorophenethylamine Hydrobromide CAS RN: 1807536-06-6
M3239 1g 5g  2-(4-Methoxyphenyl)ethylamine Hydrobromide	P2484 1g 5g  Pyrrolidine Hydrobromide CAS RN: 55810-80-5	M3285 5g 25g  Morpholine Hydrobromide CAS RN: 6377-82-8	D5092 1g 5g  Dimethylamine Hydrobromide CAS RN: 6912-12-5	D4667 1g 5g  Diethylamine Hydrobromide CAS RN: 6274-12-0
D5853 5g  Dipropylamine Hydrobromide CAS RN: 7334-96-5	D5768 5g  Diisopropylamine Hydrobromide CAS RN: 30321-74-5	D5857 5g  Dibutylamine Hydrobromide CAS RN: 10435-44-6	E1221 1g 5g  Ethylenediamine Dihydrobromide CAS RN: 624-59-9	D5090 1g 5g  1,3-Diaminopropane Dihydrobromide CAS RN: 18773-03-0
D5685 1g 5g  1,4-Diaminobutane Dihydrobromide CAS RN: 18773-04-1	D5615 1g 5g  N,N-Dimethylethylenediamine Dihydrobromide CAS RN: 1245570-04-0	D5618 1g 5g  3-(Dimethylamino)propylamine Dihydrobromide	P2490 1g 5g  Piperazine Dihydrobromide CAS RN: 59813-05-7	D5250 1g 5g  1,4-Diazabicyclo[2.2.2]octane Dihydrobromide CAS RN: 54581-69-0
F0973 1g 5g 25g  Formamidinium Hydrobromide (Low water content) CAS RN: 146958-06-7	F1244 1g 5g 25g  FAbR (99.99%, trace metals basis) CAS RN: 146958-06-7	A3292 1g 5g  Acetamidinium Hydrobromide CAS RN: 1040352-82-6	G0449 1g 5g  Guanidinium Hydrobromide CAS RN: 19244-98-5	

A3091 1g 5g  5-Azoniaspiro[4.4]nonane Bromide CAS RN: 16450-38-7	A3094 1g 5g  5-Aminovaleric Acid Hydrobromide (Low water content) CAS RN: 2173111-73-2	碘化盐 Iodide Salts	M2556 1g 5g 25g 100g $\text{CH}_3\text{NH}_2 \cdot \text{HI}$ Methylamine Hydroiodide (Low water content) CAS RN: 14965-49-2	E1045 1g 5g $\text{CH}_3\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Ethylamine Hydroiodide CAS RN: 506-58-1
P2212 1g 5g $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Propylamine Hydroiodide CAS RN: 14488-45-0	B4433 1g 5g $\text{CH}_3(\text{CH}_2)_3\text{NH}_2 \cdot \text{HI}$ Butylamine Hydroiodide CAS RN: 36945-08-1	I0935 1g 5g  Isobutylamine Hydroiodide CAS RN: 205508-75-4	B4434 1g 5g  tert-Butylamine Hydroiodide CAS RN: 39557-45-4	P2740 1g 5g $\text{CH}_3(\text{CH}_2)_4\text{NH}_2 \cdot \text{HI}$ Pentylamine Hydroiodide CAS RN: 60762-85-8
I1095 1g 5g  Isopentylamine Hydroiodide	N1157 1g 5g  Neopentylamine Hydroiodide	O0485 1g 5g $\text{CH}_3(\text{CH}_2)_7\text{NH}_2 \cdot \text{HI}$ <i>n</i> -Octylammonium Iodide CAS RN: 60734-63-6	T3785 1g 5g  tert-Octylamine Hydroiodide	D5538 1g 5g $\text{CH}_3(\text{CH}_2)_{11}\text{NH}_2 \cdot \text{HI}$ Dodecylamine Hydroiodide CAS RN: 34099-97-3
C3532 1g 5g  Cyclohexylamine Hydroiodide CAS RN: 45492-87-3	C3425 1g 5g  Cyclohexylmethylamine Hydroiodide CAS RN: 2153504-15-3	A2778 1g 5g  Aniline Hydroiodide CAS RN: 45497-73-2	F1273 1g 5g  4-Fluoroaniline Hydroiodide CAS RN: 85734-19-6	B4566 1g 5g  Benzylamine Hydroiodide (Low water content) CAS RN: 45579-91-7
F1228 1g 5g  4-Fluorobenzylamine Hydroiodide CAS RN: 2097121-30-5	T3838 1g 5g  4-(Trifluoromethyl)benzylamine Hydroiodide	D5252 1g 5g  1,4-Diazabicyclo[2.2.2]octane Dihydroiodide CAS RN: 33322-06-4	F1203 1g 5g  2-(4-Fluorophenyl)ethylamine Hydroiodide CAS RN: 1413269-55-2	M3240 1g 5g  2-(4-Methoxyphenyl)ethylamine Hydroiodide
D4555 1g 5g $\text{CH}_3\text{N}(\text{CH}_3)_2 \cdot \text{HI}$ Dimethylamine Hydroiodide CAS RN: 51066-74-1	D4643 1g 5g $\text{CH}_3\text{CH}_2\text{N}(\text{CH}_2\text{CH}_3)_2 \cdot \text{HI}$ Diethylamine Hydroiodide CAS RN: 19833-78-4	D5769 5g  Diisopropylamine Hydroiodide CAS RN: 132396-99-7	D5858 5g  Dibutylamine Hydroiodide CAS RN: 79886-80-9	P2486 1g 5g  Pyrrolidine Hydroiodide CAS RN: 45361-12-4
M3286 5g 25g  Morpholine Hydroiodide CAS RN: 58464-45-2	E1222 1g 5g $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2 \cdot 2\text{HI}$ Ethylenediamine Dihydroiodide CAS RN: 5700-49-2	D5091 1g 5g $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{NH}_2 \cdot 2\text{HI}$ 1,3-Diaminopropane Dihydroiodide CAS RN: 120675-53-8	D5686 1g 5g $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2 \cdot 2\text{HI}$ 1,4-Diaminobutane Dihydroiodide CAS RN: 916849-52-0	D5616 1g 5g  <i>N,N</i> -Dimethylethylenediamine Dihydroiodide CAS RN: 244234-52-4
D5619 1g 5g  <i>N,N</i> -Dimethyl-1,3-propanediamine Dihydroiodide	D5861 5g  3-(Dimethylamino)propylamine Dihydroiodide CAS RN: 99310-71-1	P2389 1g  1,4-Phenylenediamine Dihydroiodide CAS RN: 116469-02-4	P2492 1g 5g  Piperazine Dihydroiodide CAS RN: 58464-47-4	

H1759 5g  1-Hexyl-1,4-diazabicyclo[2.2.2]octan-1-ium Iodide CAS RN: 1009321-13-4	F0974 1g 5g 25g  Formamidinium Hydroiodide (Low water content) CAS RN: 879643-71-7	F1263 1g 5g 25g  Formamidinium Hydroiodide (99.99%, trace metals basis) CAS RN: 879643-71-7	A2902 1g 5g  Acetamidinium Hydroiodide (Low water content) CAS RN: 1452099-14-7	G0450 1g 5g  Guanidinium Hydroiodide CAS RN: 19227-70-4
I0970 1g 5g  Imidazole Hydroiodide (Low water content) CAS RN: 68007-08-9	P2672 5g  Pyridine Hydroiodide CAS RN: 18820-83-2	A3093 1g 5g  5-Azoniaspiro[4.4]nonane Iodide CAS RN: 45650-35-9	A2984 1g 5g  5-Aminovaleric Acid Hydroiodide (Low water content) CAS RN: 1705581-28-7	A3112 1g 5g  beta-Alanine Hydroiodide (Low water content) CAS RN: 2096495-59-7
类卤化盐 Pseudo Halide Salts	M2991 1g 5g $\text{CH}_3\text{NH}_2 \cdot \text{HSCN}$ Methylamine Thiocyanate CAS RN: 61540-63-4	F1153 1g 5g  Formamidinium Thiocyanate CAS RN: 1821033-48-0	G0230 25g 500g  Guanidinium Thiocyanate CAS RN: 593-84-0	F1152 1g 5g  Formamidinium Tetrafluoroborate
M2990 1g 5g $\text{CH}_3\text{NH}_3^+ \text{BF}_4^-$ Methylamine Tetrafluoroborate CAS RN: 42539-74-2	M2989 1g 5g $\text{CH}_3\text{NH}_3^+ \text{PF}_6^-$ Methylammonium Hexafluorophosphate CAS RN: 28302-50-3	M3134 1g 5g $\text{CH}_3\text{NH}_2 \cdot \text{HOCN}$ Methylamine Cyanate CAS RN: 63405-91-4	T0914 25g 100g 500g  Tetrabutylammonium Tetrafluoroborate CAS RN: 429-42-5	T2648 25g  Tetrabutylammonium Tetrafluoroborate (Br < 0.02 %) CAS RN: 429-42-5
卤化铅 Lead Halides	L0279 1g 5g 25g 100g 1kg PbI_2 Lead(II) Iodide (99.99%, trace metals basis) [for Perovskite precursor] CAS RN: 10101-63-0	L0288 1g 5g 25g PbBr_2 Lead(II) Bromide [for Perovskite precursor] CAS RN: 10031-22-8	L0346 1g 5g PbBr_2 Lead(II) Bromide (Low water content) [for Perovskite precursor] CAS RN: 10031-22-8	
L0291 1g 5g PbCl_2 Lead(II) Chloride (purified by sublimation) [for Perovskite precursor] CAS RN: 7758-95-4	L0292 1g 5g 25g PbCl_2 Lead(II) Chloride [for Perovskite precursor] CAS RN: 7758-95-4	C3569 1g 5g CsPbBr_3 Cesium Lead Tribromide (Low water content) CAS RN: 15243-48-8	C3570 1g 5g CsPbI_3 Cesium Lead Triiodide (Low water content) CAS RN: 18041-25-3	
其它铅化合物 Other Lead Compounds	L0315 1g 5g 25g  Lead(II) Acetate [for Perovskite precursor] CAS RN: 301-04-2	L0330 25g 100g  Lead(II) Acetate Trihydrate CAS RN: 6080-56-4		
卤化铯 Cesium Halides	C2202 25g 100g CsBr Cesium Bromide CAS RN: 7787-69-1	C2203 25g 100g CsCl Cesium Chloride CAS RN: 7647-17-8	C2205 25g CsI Cesium Iodide CAS RN: 7789-17-5	

卤化铋 Bismuth Halides

B5787 5g 25g

Bismuth(III) Iodide
Anhydrous
CAS RN: 7787-64-6

卤化锡 Tin Halides

T3449 1g 5g

Tin(II) Iodide
[for Perovskite precursor]
CAS RN: 10294-70-9

T3570 1g 5g

Tin(II) Chloride
[for Perovskite precursor]
CAS RN: 7772-99-8

T3573 1g 5g

Tin(II) Bromide
[for Perovskite precursor]
CAS RN: 10031-24-0



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