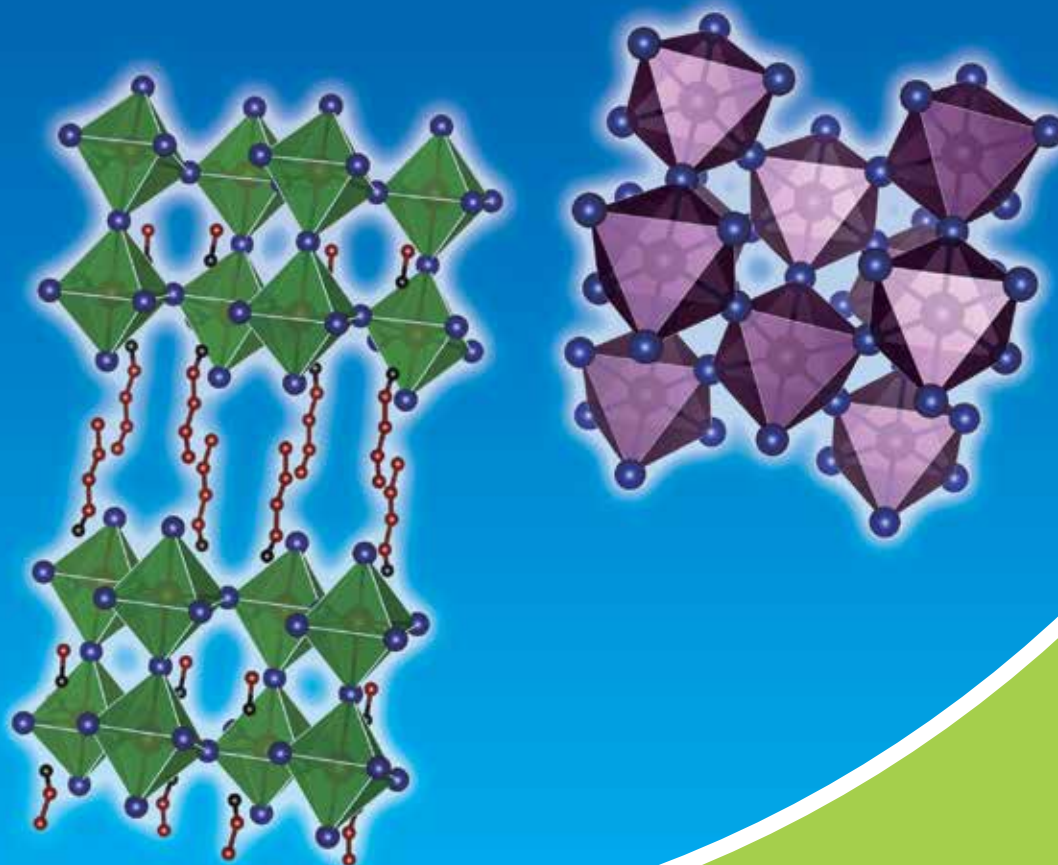


Organic-Inorganic Perovskite Precursors



Lead Halides

Other Lead Compounds

Cesium Halides

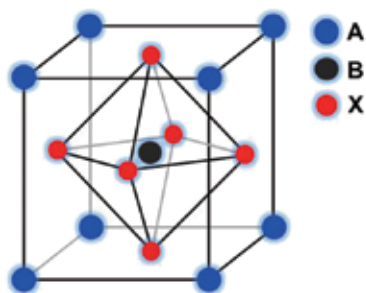
Bismuth Halides

Tin Halides

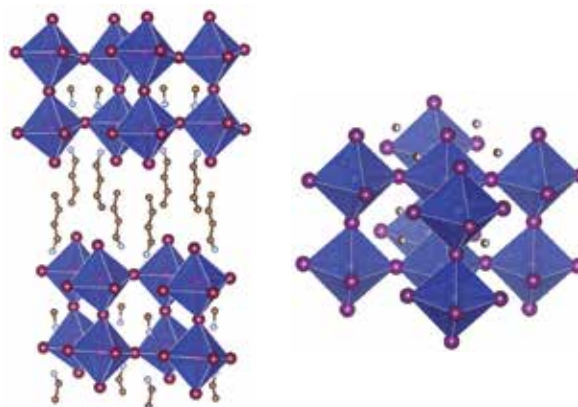
Organic Onium Salts

Organic-Inorganic Perovskite Precursors

"Perovskite" originates from the mineral name of calcium titanate (CaTiO_3) and the compounds with formula of ABX_3 generally belong to a perovskite-type compound, where the A is a divalent and B is a tetravalent metal ion. A perovskite with cubic or orthorhombic phases shows ferroelectricity, for instance, barium titanate (BaTiO_3) is a ferroelectric or piezoelectric material.¹⁾ High temperature superconductive oxides with a unit of copper oxide are obtained from all perovskite compounds.²⁾ These perovskite compounds consist of metal ions and oxygen atoms, and are manufactured by a physical procedure (eg. sintering method).³⁾ Modification of the metal ion and a changing ratio of the metal ion components can drastically control physical properties of the perovskite. In addition to the oxide perovskites, halide-based perovskites are also well known.



On the other hand, one can replace the cationic component with an organic ammonium at the A site. In this case, a chemical method can provide a perovskite compound. This perovskite compound is called an "organic-inorganic perovskite compound", because it contains an organic component. A metal ion component usually involves tin or lead.^{4,5)} This perovskite compound has the general formula $[(\text{RNH}_3)_m\text{MX}_n]$, in which modifications of metal (M), halide (X) and organic groups (R) precisely control physical properties. Among them, the tin perovskite is relatively better for electrical conduction,⁶⁾ and the lead one is better for optical properties.⁷⁾ A chemical modification of the halide controls band gap.⁸⁾ Selection of organic onium halide, metal halide and their mixing ratio changes the component ratio of the halide. The organic groups are selected from methyl, long alkyls, phenyl, benzyl, phenethyl and so on. Diversity of these organic groups allows controlling the structure of a perovskite compound. For instance, a perovskite compound with R = methyl provides $[(\text{MeNH}_3)\text{MX}_3]$ having a three-dimensional cubic perovskite structure.⁹⁾ A perovskite compound with R = $\text{C}_n\text{H}_{2n+1}$ ($n \geq 2$) provides a two-dimensional perovskite layer and the length of alkyl group can control the inter-layer distance.¹⁰⁾



An application of an organic-inorganic perovskite is a perovskite solar cell.¹¹⁻¹⁵⁾ This solar cell can usually be fabricated by the three-dimensional cubic perovskite $[(\text{MeNH}_3)\text{MX}_3]$. Doping effects of formamidinium¹⁶⁾ and cesium cations¹⁷⁾ to the A site were also investigated for the perovskite solar cell research. Wakamiya *et al.* recently developed a ready-to-use perovskite precursor, $\text{MeNH}_3/\text{PbI}_2$ -DMF complex, enabling us to fabricate a well-uniformed crystalline film by a solution method.¹⁸⁾ Research on the perovskite solar cell recently received much attention. Power conversion efficiency of this solar cell is more than those of organic photovoltaics (OPV) and dye-sensitized solar cells (DSSC), and the device can be fabricated by a solution method at low cost.

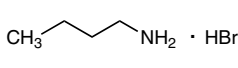
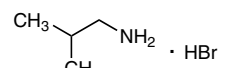
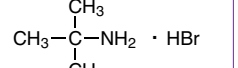
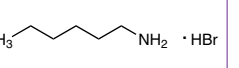
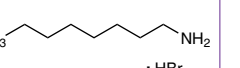
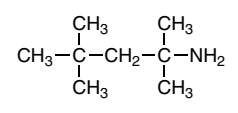
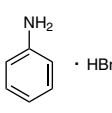
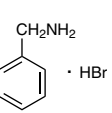
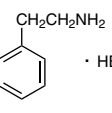
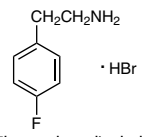
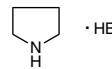
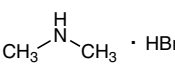
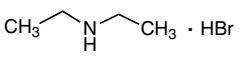
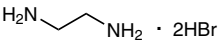
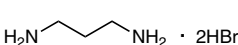
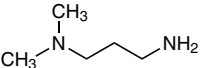
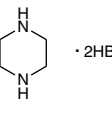
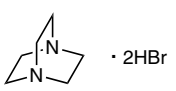
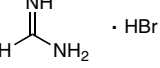
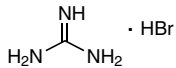
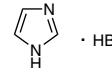
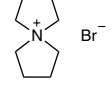
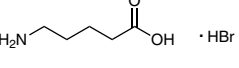

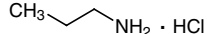
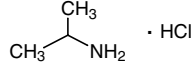
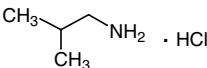
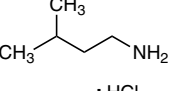

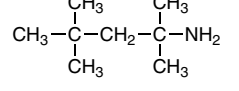
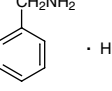
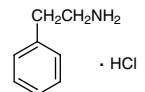
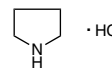
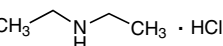
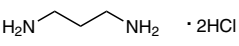
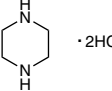
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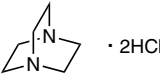
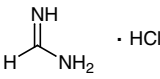
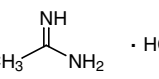
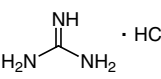
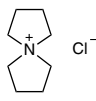
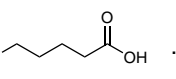
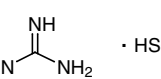
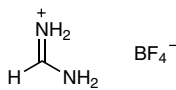
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Lead Halides	P2415 1g 5g 25g $\text{CH}_3\text{NH}_3\text{PbI}_3$ / DMF PbI ₂ /MAI(1:1) - DMF Complex (99.99%, trace metals basis) CAS RN: 10101-63-0	L0279 1g 5g 25g 100g 1kg PbI ₂ Lead(II) Iodide (99.99%, trace metals basis) CAS RN: 10101-63-0	L0288 1g 5g 25g PbBr ₂ Lead(II) Bromide CAS RN: 10031-22-8	
	L0291 1g 5g PbCl ₂ Lead(II) Chloride (purified by sublimation) CAS RN: 7758-95-4	L0292 1g 5g 25g PbCl ₂ Lead(II) Chloride CAS RN: 7758-95-4	C3569 1g 5g CsPbBr ₃ Cesium Lead Tribromide (Low water content) CAS RN: 15243-48-8	
	Other Lead Compounds	L0315 1g 5g 25g $\left[\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}^- \right]_2 \text{Pb}^{2+}$ Acetic Acid Lead(II) Salt CAS RN: 301-04-2	L0330 25g 100g $\left[\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}^- \right]_2 \text{Pb}^{2+} \cdot 3\text{H}_2\text{O}$ Lead(II) Acetate Trihydrate CAS RN: 6080-56-4	
Cesium Halides		C2205 25g CsI Cesium Iodide CAS RN: 7789-17-5	C2202 25g 100g CsBr Cesium Bromide CAS RN: 7787-69-1	C2203 25g 100g CsCl Cesium Chloride CAS RN: 7647-17-8
		Bismuth Halides	B5787 5g 25g BiI ₃ Bismuth(III) Iodide Anhydrous CAS RN: 7787-64-6	
	T3449 1g 5g SnI ₂ Tin(II) Iodide [for Perovskite precursor] CAS RN: 10294-70-9			
Tin Halides				

Organic Onium Salts		Iodide Salts		M2556 1g 5g 25g 100g	E1045 1g 5g
				$\text{CH}_3\text{NH}_2 \cdot \text{HI}$ Methylamine Hydroiodide CAS RN: 14965-49-2	$\text{CH}_3\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Ethylamine Hydroiodide CAS RN: 506-58-1
P2212 1g 5g	I0934 1g 5g	B4433 1g 5g	I0935 1g 5g	B4434 1g 5g	
$\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Propylamine Hydroiodide CAS RN: 14488-45-0	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Isopropylamine Hydroiodide CAS RN: 66735-20-4	$\text{CH}_3(\text{CH}_2)_3\text{NH}_2 \cdot \text{HI}$ Butylamine Hydroiodide CAS RN: 36945-08-1	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Isobutylamine Hydroiodide CAS RN: 205508-75-4	$\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{NH}_2 \cdot \text{HI}$ <i>tert</i> -Butylamine Hydroiodide CAS RN: 39557-45-4	
I1095 1g 5g	T3785 1g 5g	D5538 1g 5g	C3532 1g 5g	C3425 1g 5g	
$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Isopentylamine Hydroiodide	$\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{C}(\text{CH}_3)_2\text{NH}_2 \cdot \text{HI}$ <i>tert</i> -Octylamine Hydroiodide	$\text{CH}_3(\text{CH}_2)_{11}\text{NH}_2 \cdot \text{HI}$ Dodecylamine Hydroiodide CAS RN: 34099-97-3	$\text{C}_6\text{H}_{11}\text{NH}_2 \cdot \text{HI}$ Cyclohexylamine Hydroiodide CAS RN: 45492-87-3	$\text{C}_6\text{H}_{11}\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Cyclohexanemethylamine Hydroiodide	
A2778 1g 5g	B4566 1g 5g	P2213 1g 5g	F1203 1g 5g	D4555 1g 5g	
$\text{C}_6\text{H}_5\text{NH}_2 \cdot \text{HI}$ Aniline Hydroiodide CAS RN: 45497-73-2	$\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2 \cdot \text{HI}$ Benzylamine Hydroiodide CAS RN: 45579-91-7	$\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{NH}_2 \cdot \text{HI}$ 2-Phenylethylamine Hydroiodide CAS RN: 151059-43-7	$\text{C}_6\text{H}_4(\text{F})(\text{CH}_2\text{CH}_2\text{NH}_2) \cdot \text{HI}$ 2-(4-Fluorophenyl)-ethylamine Hydroiodide CAS RN: 1413269-55-2	$(\text{CH}_3)_2\text{NCH}_3 \cdot \text{HI}$ Dimethylamine Hydroiodide CAS RN: 51066-74-1	
D4643 1g 5g	P2486 1g 5g	E1222 1g 5g	D5091 1g 5g	D5619 1g 5g	
$\text{CH}_3\text{CH}_2\text{N}(\text{H})\text{CH}_2\text{CH}_3 \cdot \text{HI}$ Diethylamine Hydroiodide CAS RN: 19833-78-4	$\text{C}_4\text{H}_8\text{NH} \cdot \text{HI}$ Pyrrolidine Hydriodide CAS RN: 45361-12-4	$\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2 \cdot 2\text{HI}$ Ethylenediamine Dihydroiodide CAS RN: 5700-49-2	$\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{NH}_2 \cdot 2\text{HI}$ 1,3-Diaminopropane Dihydroiodide CAS RN: 120675-53-8	$(\text{CH}_3)_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{NH}_2 \cdot 2\text{HI}$ <i>N,N</i> -Dimethyl-1,3-propanediammonium Diiodide	
P2389 1g	P2492 1g 5g	F0974 1g 5g 25g	A2902 1g 5g	G0450 1g 5g	
$\text{C}_6\text{H}_4(\text{NH}_2)_2 \cdot 2\text{HI}$ 1,4-Phenylenediamine Dihydroiodide CAS RN: 116469-02-4	$\text{C}_4\text{H}_{10}\text{N}_2 \cdot 2\text{HI}$ Piperazine Dihydroiodide CAS RN: 58464-47-4	$\text{H}_2\text{C}=\text{NH} \cdot \text{HI}$ Formamidine Hydroiodide CAS RN: 879643-71-7	$\text{CH}_3\text{C}(\text{NH})=\text{NH}_2 \cdot \text{HI}$ Acetamidine Hydroiodide CAS RN: 1452099-14-7	$\text{H}_2\text{N}-\text{C}(\text{NH})=\text{NH}_2 \cdot \text{HI}$ Guanidine Hydroiodide CAS RN: 19227-70-4	
I0970 1g 5g	A3093 1g 5g	A2984 1g 5g	A3112 1g 5g	A3113 1g 5g	
$\text{C}_3\text{H}_4\text{N}_2 \cdot \text{HI}$ Imidazole Hydroiodide CAS RN: 68007-08-9	$\text{C}_9\text{H}_{15}\text{N}_2 \cdot \text{I}^-$ 5-Azoniaspiro[4.4]nonane Iodide CAS RN: 45650-35-9	$\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH} \cdot \text{HI}$ 5-Aminovaleric Acid Hydroiodide CAS RN: 1705581-28-7	$\text{H}_2\text{NCH}_2\text{CH}_2\text{COOH} \cdot \text{HI}$ <i>H</i> -β-Ala-OH·HI (Low water content) CAS RN: 2096495-59-7	$\text{H}_2\text{NCH}_2\text{CH}_2\text{COOH} \cdot \text{HI}$ GABA·HI CAS RN: 2096495-60-0	
	M2589 1g 5g 25g	E0056 25g 500g	P2502 1g 5g	I1041 1g 5g	
	$\text{CH}_3\text{NH}_2 \cdot \text{HBr}$ Methylamine Hydrobromide CAS RN: 6876-37-5	$\text{CH}_3\text{CH}_2\text{NH}_2 \cdot \text{HBr}$ Ethylamine Hydrobromide CAS RN: 593-55-5	$\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 \cdot \text{HBr}$ Propylamine Hydrobromide CAS RN: 4905-83-3	$\text{CH}_3\text{CH}(\text{CH}_3)\text{NH}_2 \cdot \text{HBr}$ Isopropylamine Hydrobromide CAS RN: 29552-58-7	
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	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 $\text{CH}_3(\text{CH}_2)_{11}\text{NH}_2 \cdot \text{HBr}$ Dodecylamine Hydrobromide CAS RN: 26204-55-7	A2985 1g 5g  Aniline Hydrobromide CAS RN: 542-11-0	B5185 1g 5g  Benzylamine Hydrobromide CAS RN: 37488-40-7	P2388 1g 5g  2-Phenylethylamine Hydrobromide CAS RN: 53916-94-2
F1229 1g 5g  2-(4-Fluorophenyl)ethylamine Hydrobromide CAS RN: 1807536-06-6	P2484 1g 5g  Pyrrolidine Hydrobromide CAS RN: 55810-80-5	D5092 1g 5g  Dimethylamine Hydrobromide CAS RN: 6912-12-5	D4667 1g 5g  Diethylamine Hydrobromide CAS RN: 6274-12-0	E1221 1g 5g  Ethylenediamine Dihydrobromide CAS RN: 624-59-9
D5090 1g 5g  1,3-Diaminopropane Dihydrobromide CAS RN: 18773-03-0	D5618 1g 5g  N,N-Dimethyl-1,3-propanediamine 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  Formamidine Hydrobromide CAS RN: 146958-06-7
G0449 1g 5g  Guanidine Hydrobromide CAS RN: 19244-98-5	I1006 1g 5g  Imidazole Hydrobromide (Low water content) CAS RN: 101023-55-6	A3091 1g 5g 25g  5-Azoniaspiro[4.4]nonane Bromide CAS RN: 16450-38-7	A3094 1g 5g  5-AVABr (Low water content)	Chloride Salts
M0138 25g 500g $\text{CH}_3\text{NH}_2 \cdot \text{HCl}$ Methylamine Hydrochloride CAS RN: 593-51-1	E0205 25g 500g  Ethylamine Hydrochloride CAS RN: 557-66-4	P0522 25g  Propylamine Hydrochloride CAS RN: 556-53-6	I0166 25g 100g 500g  Isopropylamine Hydrochloride CAS RN: 15572-56-2	
I0096 25g 500g  Isobutylamine Hydrochloride CAS RN: 5041-09-8	I0083 1g 5g  Isopentylamine Hydrochloride CAS RN: 541-23-1	O0484 1g 5g  n-Octylamine Hydrochloride CAS RN: 142-95-0	T3784 1g 5g  tert-Octylamine Hydrochloride CAS RN: 58618-91-0	B0407 25g 100g 500g  Benzylamine Hydrochloride CAS RN: 3287-99-8
P0086 25g 100g 500g  2-Phenylethylamine Hydrochloride CAS RN: 156-28-5	P2485 1g 5g  Pyrrolidine Hydrochloride CAS RN: 25150-61-2	D0468 25g 500g  Diethylamine Hydrochloride CAS RN: 660-68-4	D5253 1g 5g  1,3-Diaminopropane Dihydrochloride (Low water content) CAS RN: 10517-44-9	P2491 1g 5g  Piperazine Dihydrochloride CAS RN: 142-64-3

Organic-Inorganic Perovskite Precursors

<p>D5251 1g 5g</p>  <p>1,4-Diazabicyclo[2.2.2]- octane Dihydrochloride CAS RN: 49563-87-3</p>	<p>F0103 5g 25g</p>  <p>Formamidine Hydrochloride CAS RN: 6313-33-3</p>	<p>A0008 25g 500g</p>  <p>Acetamidine Hydrochloride CAS RN: 124-42-5</p>	<p>G0162 25g 500g</p>  <p>Guanidine Hydrochloride CAS RN: 50-01-1</p>	<p>A3092 1g 5g</p>  <p>5-Azoniaspiro[4.4]nonane Chloride CAS RN: 98997-63-8</p>
<p>A0436 1g 5g</p>  <p>5-AVACI (Low water content) CAS RN: 627-95-2</p>	<p>Pseudo Halide Salts</p>	<p>M2991 1g 5g</p> <p>$\text{CH}_3\text{NH}_2 \cdot \text{HSCN}$</p> <p>Methylamine Thiocyanate CAS RN: 61540-63-4</p>	<p>G0230 25g 500g</p>  <p>Guanidine Thiocyanate CAS RN: 593-84-0</p>	<p>F1152 1g 5g</p>  <p>Formamidine Tetrafluoroborate</p>
<p>M2990 1g 5g</p> <p>$\text{CH}_3\text{NH}_3^+ \text{BF}_4^-$</p> <p>Methylamine Tetrafluoroborate CAS RN: 42539-74-2</p>		<p>M3134 1g 5g</p> <p>$\text{CH}_3\text{NH}_2 \cdot \text{HOCN}$</p> <p>Methylamine Cyanate CAS RN: 63405-91-4</p>		

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