

A New Conceptual Ionic Crystal

NCIS: Non-Coulombic Ionic Solid Formation of Crystals from a Multinuclear Metal Complex

Prof. Takumi KONNO (Osaka University)

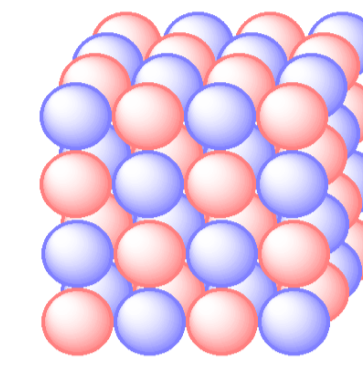
1. Introduction

In **natural ionic solids**, the spatial arrangement of cations and anions is strictly ruled by Coulombic force, and that their positions are tightly fixed.

A species of ionic solids we synthesized are ruled by non-Coulombic interactions. The unique structures lead to some novel phenomena and various sorts of functionalities.

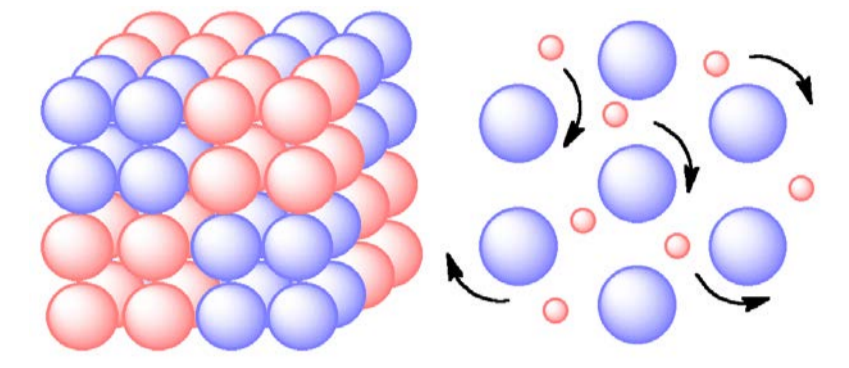
We named the new conceptual ionic solid species as **Non-Coulombic Ionic Solids (NCIS)**.

Natural Ionic Solid
(Coulombic Ionic Solid)



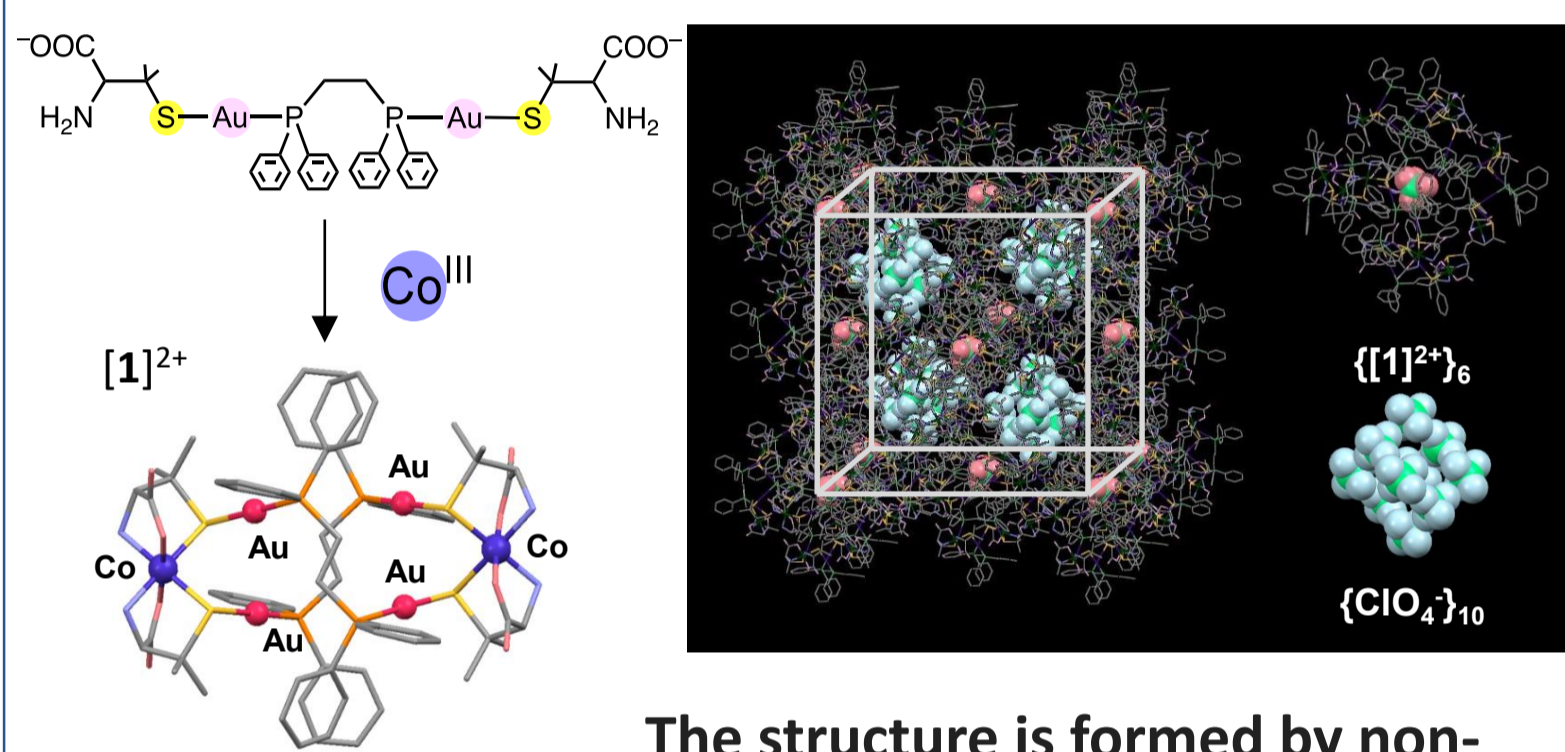
Classical structure

NCIS
(Non Coulombic Ionic Solid)



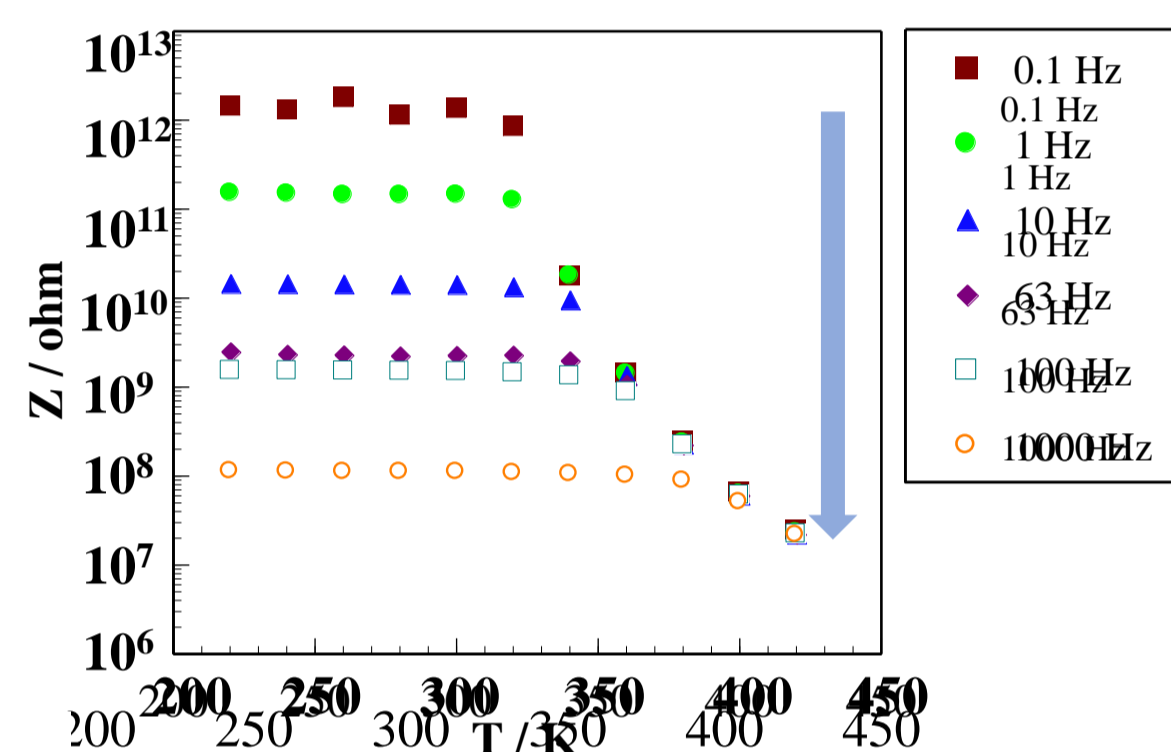
Charge-separation Ion-fluid

2. Dielectric Response of Charge-Separation-type NCIS



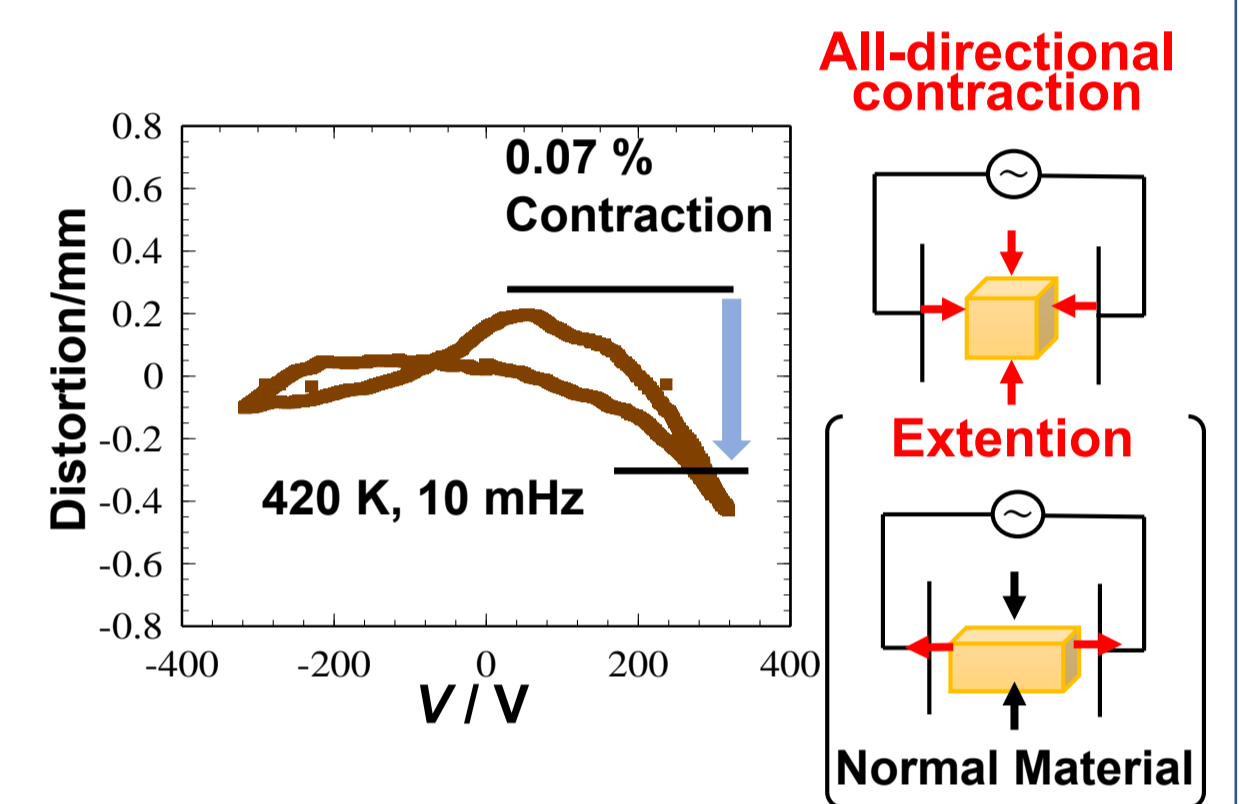
The structure is formed by non-Coulombic interactions from polynuclear metal complex cations and anion clusters

Crystal Structure of $[1]X_2 \cdot nH_2O$



It can be used for the resistance thermometer because the impedance decreases as the temperature rises.

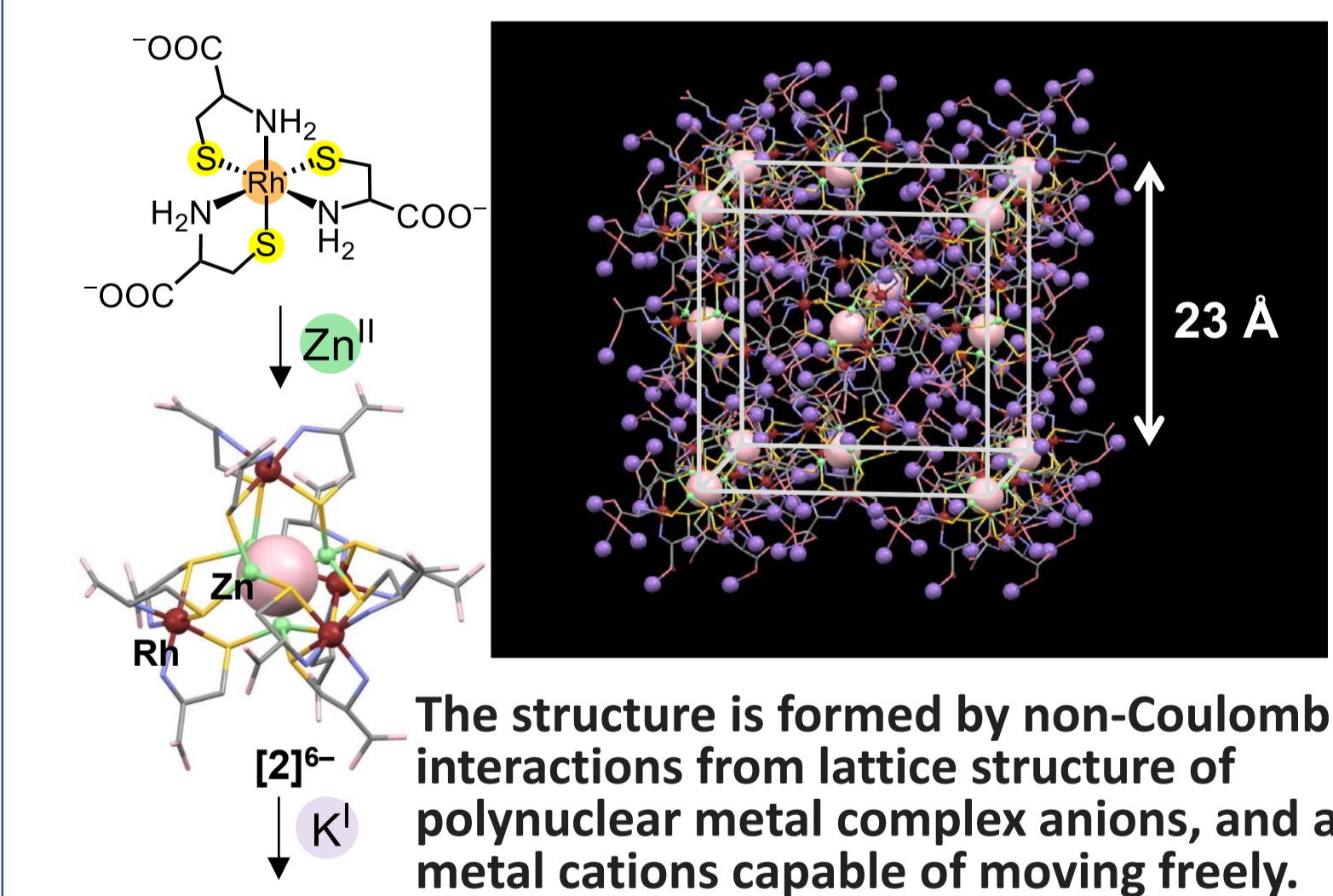
Thermal Resistance Change



The isotropic volume shrinkage is caused by the changes in position and orientation of anion clusters and water molecules in response to electric fields.

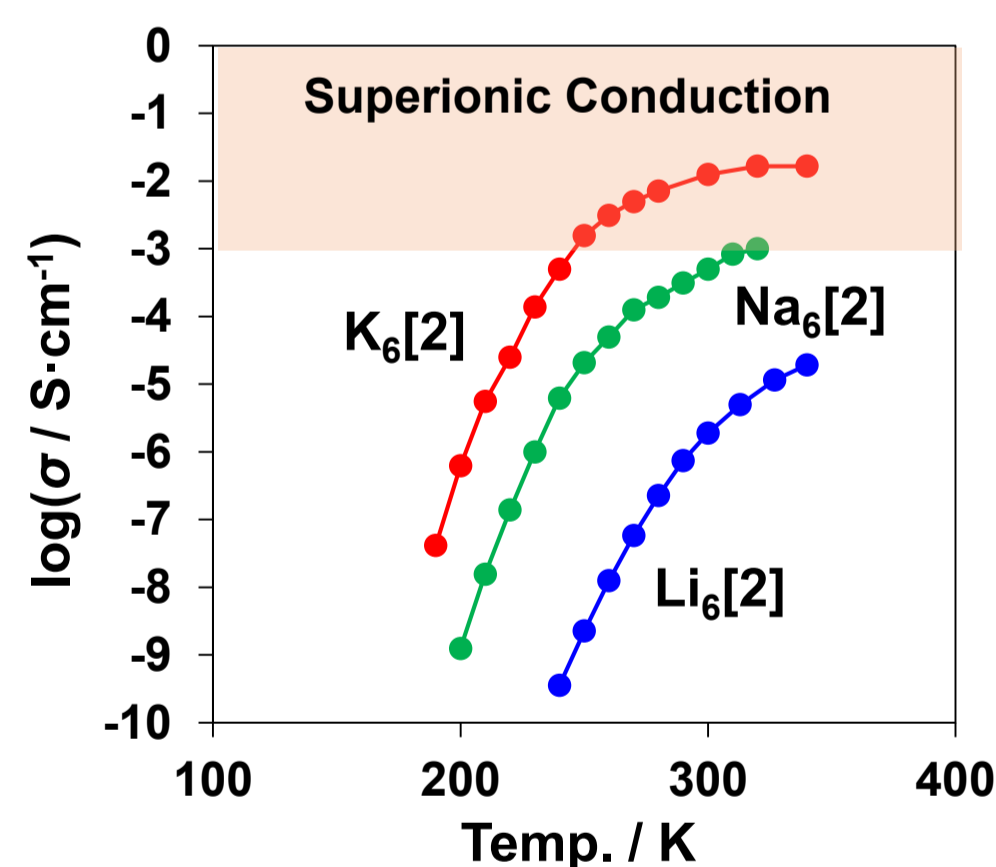
Negative Electrostriction

3. Fast Ionic Conduction of Ion-fluid-type NCIS



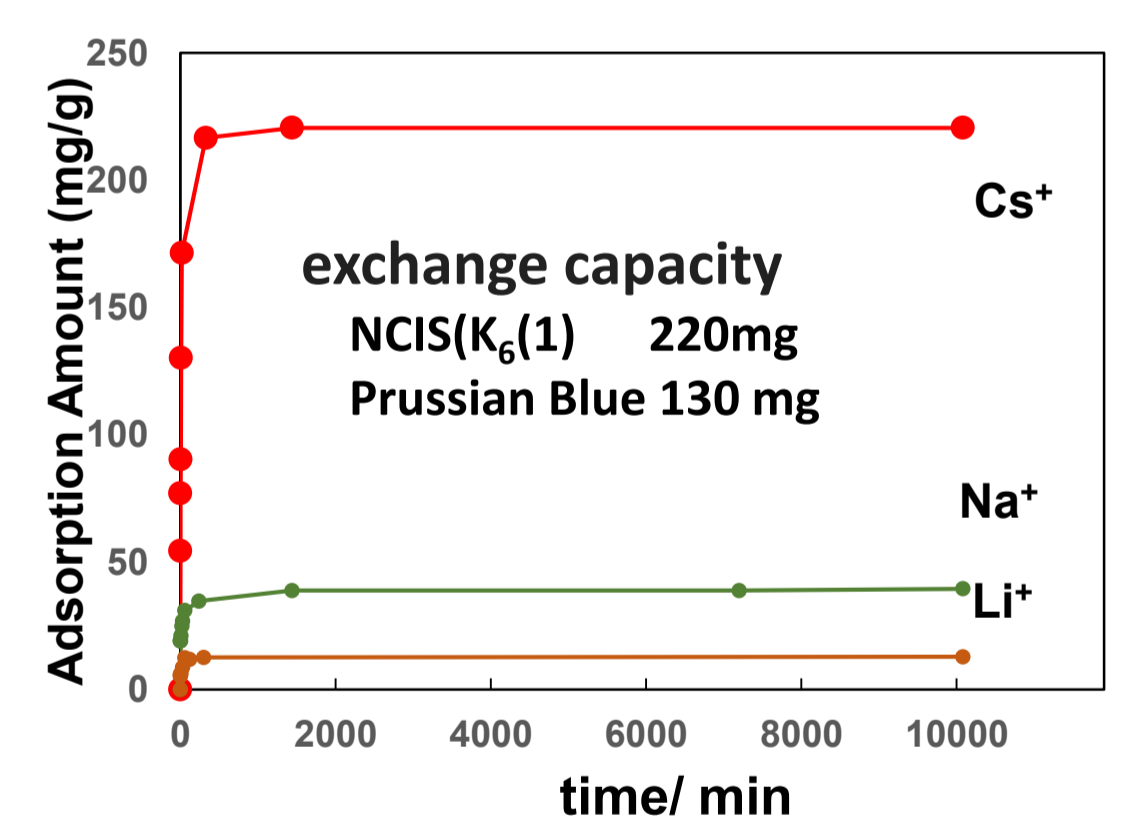
The structure is formed by non-Coulombic interactions from lattice structure of polynuclear metal complex anions, and alkali metal cations capable of moving freely.

Structure of $K_6[2] \cdot nH_2O$



The potassium salt shows superionic conduction above room temperature in Ion-Fluid-type NCIS.

Superionic K^+ Conduction



Alkali metal ions in crystal are quickly, completely exchanged just by soaking crystals in solution.

Quick ion exchange

4. Application Examples

- Actuator for micro devices
- Adsorbent of cesium ion
- All solid-state Battery
- Negative Temperature Coefficient (NTC) Thermistor

5. Patent Licensing Available

Patent No.: WO2018/056237

Patent No.: WO2018/079831

JST/ IP Management and Licensing Group

Phone: +81-3-5214-8486 E-mail: license@jst.go.jp

