



TOYO

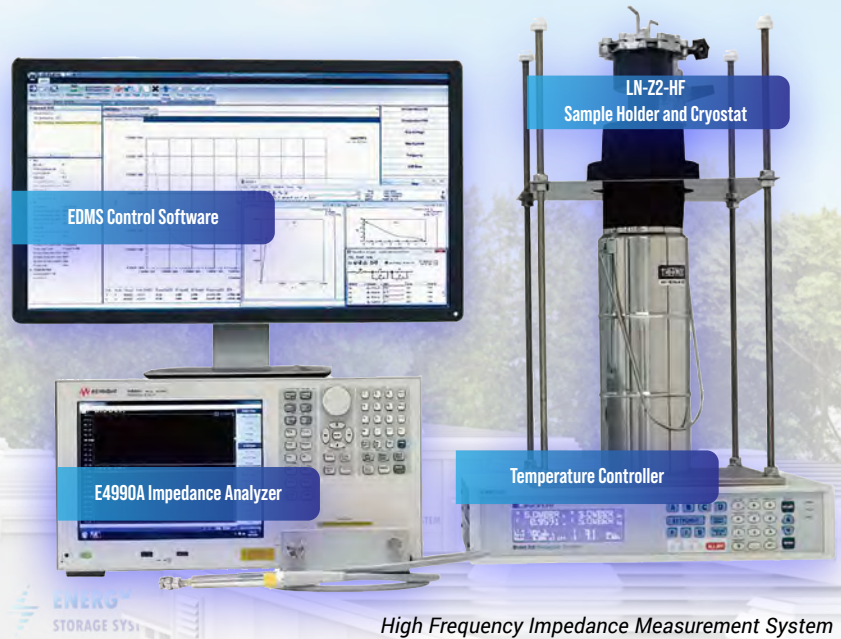
LN-Z2-HF/HT-Z2-HF High-Frequency Impedance Measurement System DATASHEET

INTRODUCTION

TOYO's high frequency impedance measurement system (see graphic on the right) is ideal for in-depth evaluation of the ionic and electronic conductivity of solid electrolytes, as well as the comprehensive assessment of the physical properties of dielectric materials such as ceramics. It provides precise and reliable measurements crucial for advancing research and development in these fields.

The system features an advanced automatic control mechanism that allows for extensive temperature regulation (see graphic below), ensuring accurate experimental conditions across a broad temperature range. Additionally, it supports high-frequency measurement capabilities up to 100 MHz, enabling detailed analysis and characterization of materials under various conditions.

This combination of wide-range temperature control and high-frequency measurement makes it a versatile and powerful tool for researchers and engineers working on cutting-edge material science research and development.

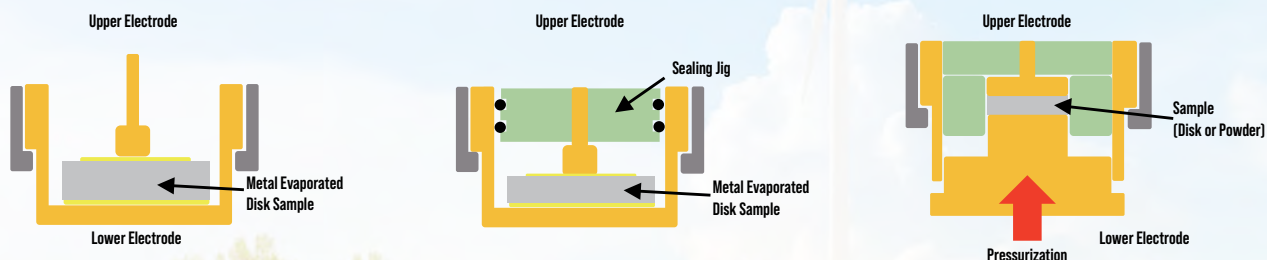


KEY ADVANTAGES

- Frequency range from 20Hz to 100MHz
- Temperature range from 90K to 473K
- Fully automated temperature variation and impedance measurement with dedicated control software
- Sample size max 13mm ϕ x thickness 3mm
- Equipped with sealed and pressurized sample holders (LN-Z2-HF)
- Can export to ZView EIS software easily



Heating Furnace and Sample Holder for HT-Z2-HF



HOLDERS (for LN-Z2-HF)			
	LN-Z2-HF-SH	LN-Z2-HF-GT	LN-Z2-HF-PH
Holder Type	Standard Holder	Sealed Holder	Pressurized Holder
Contact Type	2 Electrodes; Spring Type	2 Electrodes; Spring Type	2 Electrodes Pressured Type (max torque : 20Nm = 70MPa)
Sample Size	Area <13mm ϕ ; Thickness 0.8~3mm	Area <13 mm ϕ ; Thickness 0.8~3mm	Area <10 mm ϕ ; Thickness <3mm
Seal Capability	NA	O	Δ

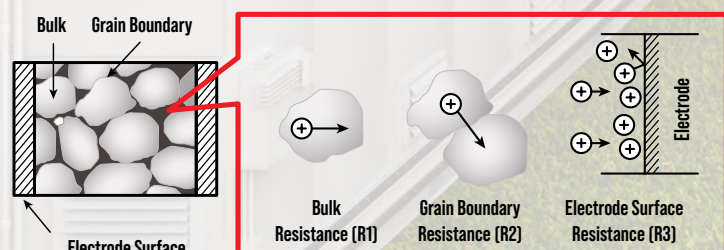
EVALUATION OF BULK AND GRAIN BOUNDARIES

Let's discuss the evaluation of bulk and grain boundaries with temperature control function and high-frequency impedance measurements.

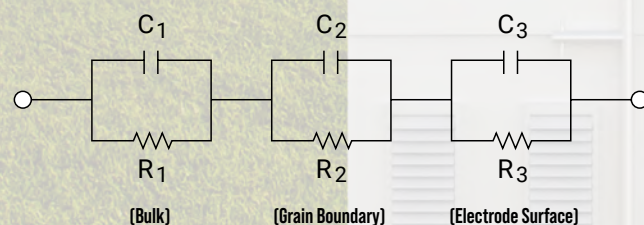
When impedance measurements are performed on samples that are pressed and sintered particles of oxides or sulfides, the ideal outcome is to separate the resistance into three components: bulk resistance, grain boundary resistance (interface between particles), and electrode interface resistance.

To determine properties such as the activation energy of materials, resistance of each component is measured at various temperatures, and plots are obtained. However, for particles with high mobility and low resistance, it was not possible to obtain bulk and grain boundary resistance at frequencies around 1 MHz.

The sample holder developed by our company enables measurements up to 100 MHz over a wide temperature range from 90K (-183°C) to 873K (600°C). This system allows for accurate evaluation of the bulk and grain boundary characteristics of samples.



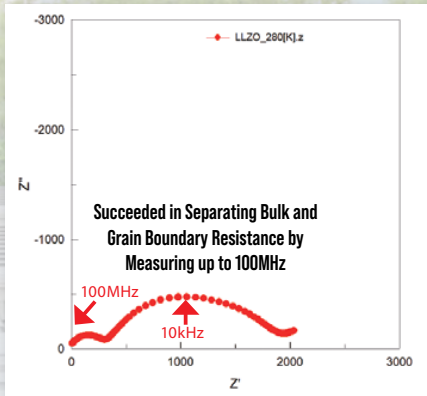
Equivalent Circuit of Solid Electrolyte



MEASUREMENT EXAMPLE ONE: CALCULATION OF BULK/GRAIN BOUNDARY ACTIVATION ENERGY OF LLZT SOLID ELECTROLYTE

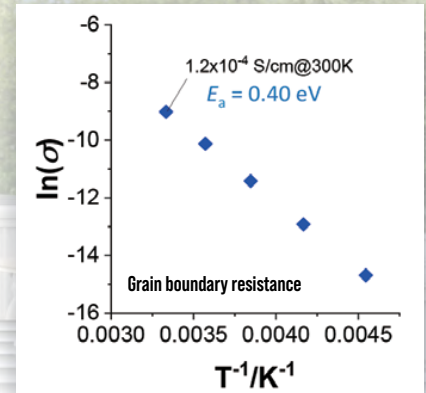
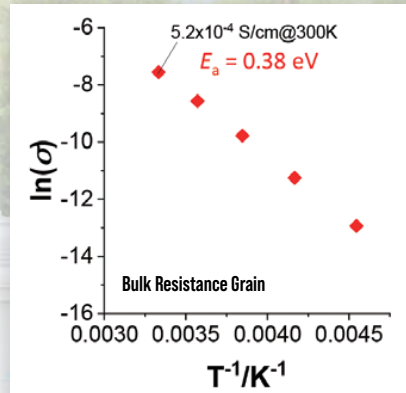
The following is the result from a technical collaboration with Dr. Narumi Ota at the National Institute for Materials Science.

- Measurement Sample: LLZT
- Frequency Range: 20Hz~100MHz
- Measurement Temperatures: 220K, 240K, 260K, 280K, 300K



Impedance Measurement Results (280K)

Measured at Each Temperature

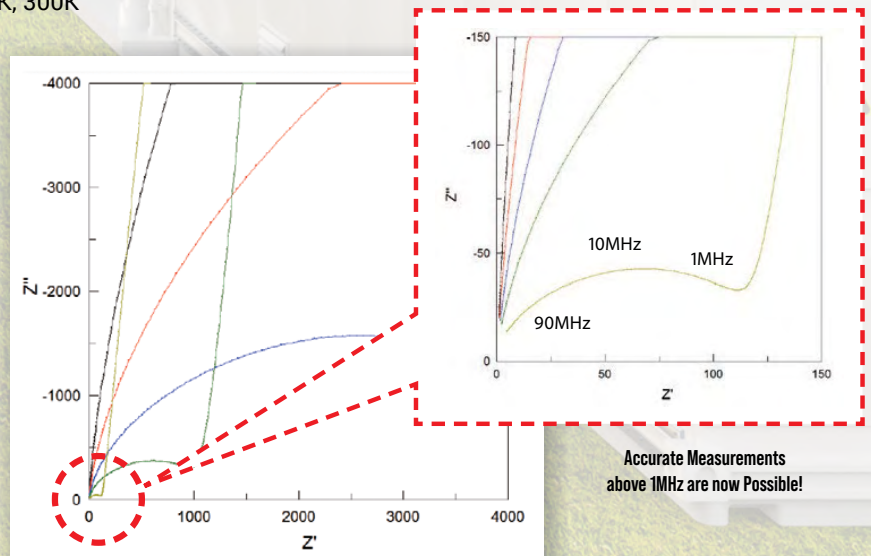
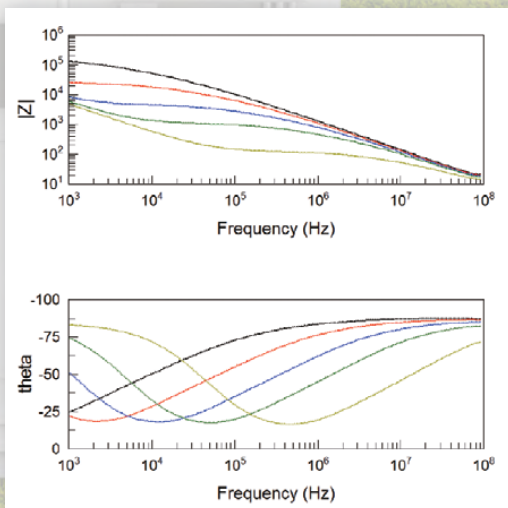


Calculation of Activation Energy using Arrhenius Plot

MEASUREMENT EXAMPLE ONE: CALCULATION OF BULK/GRAIN BOUNDARY ACTIVATION ENERGY OF LLZT SOLID ELECTROLYTE

The following is the result from a technical collaboration with Professor Yoshiyuki Inaguma of the Department of Chemistry, Faculty of Science at Gakushuin University.

- Measurement Sample: LLTO
- Frequency Range: 1kHz~100MHz
- Measurement Temperatures: 170K, 200K, 225K, 250K, 300K



SPECIFICATIONS		
	LN-Z2-HF	HT-Z2-HF
Frequency	20Hz~100MHz	
AC Voltage	5mVrms~1Vrms	
DC Voltage	± 40V	
Correction Function	Open/Short/Load	
Measurement Range	25mΩ~40MΩ	
Temperature Range	80K~473K (Control temperature: 90K~ 473K)	Room temperature to 600°C (Control temperature: 100°C~600°C)
Sample Atmosphere	Helium gas displacement, atmospheric or gas replacement	Atmospheric or gas displacement
Sample Connection	LN-Z2-HF sample holder See options	2 terminals spring type
Sample Size	Area: 13mmφ or less Thickness: 3mm or less	Area: 20mmφ or less Thickness: 3mm or less
Options	■ Standard sample holder ■ Sealed sample holder ■ Pressure type sample holder ■ Bias voltage sample measurement option ■ Overheat prevention kit	N/A



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05/28/2024 (SCW)