

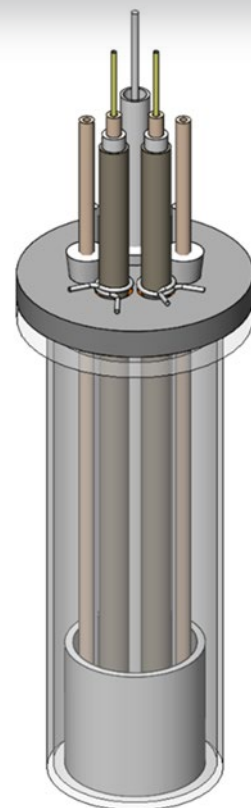
Custom High-Temperature Reference Electrodes

Robust thermodynamic high-temperature reference electrodes (HTREs) for performing electrochemical molten salt R&D are required, but are not commercially available

Researchers make their own HTREs with inherent variability due to differences in design and fabrication methods. HiFunda will provide custom HTREs for your application so your team can focus on electrochemical R&D and process/product development.

HiFunda has developed and demonstrated the HTRE technology as part of DOE SBIR projects where we teamed with Idaho National Laboratory and the University of Utah to develop and demonstrate HTREs for operation in molten chloride and fluoride salts

HiFunda's custom Ag/AgCl, Ag/AgF, and Ni/NiF₂ HTREs are designed, built, and characterized for your application. Each HTRE has three-fold functionality 1) stable thermodynamic reference potential, 2) integral temperature sensor, 3) redox sensor.



SBIR Projects and Technical Presentations:

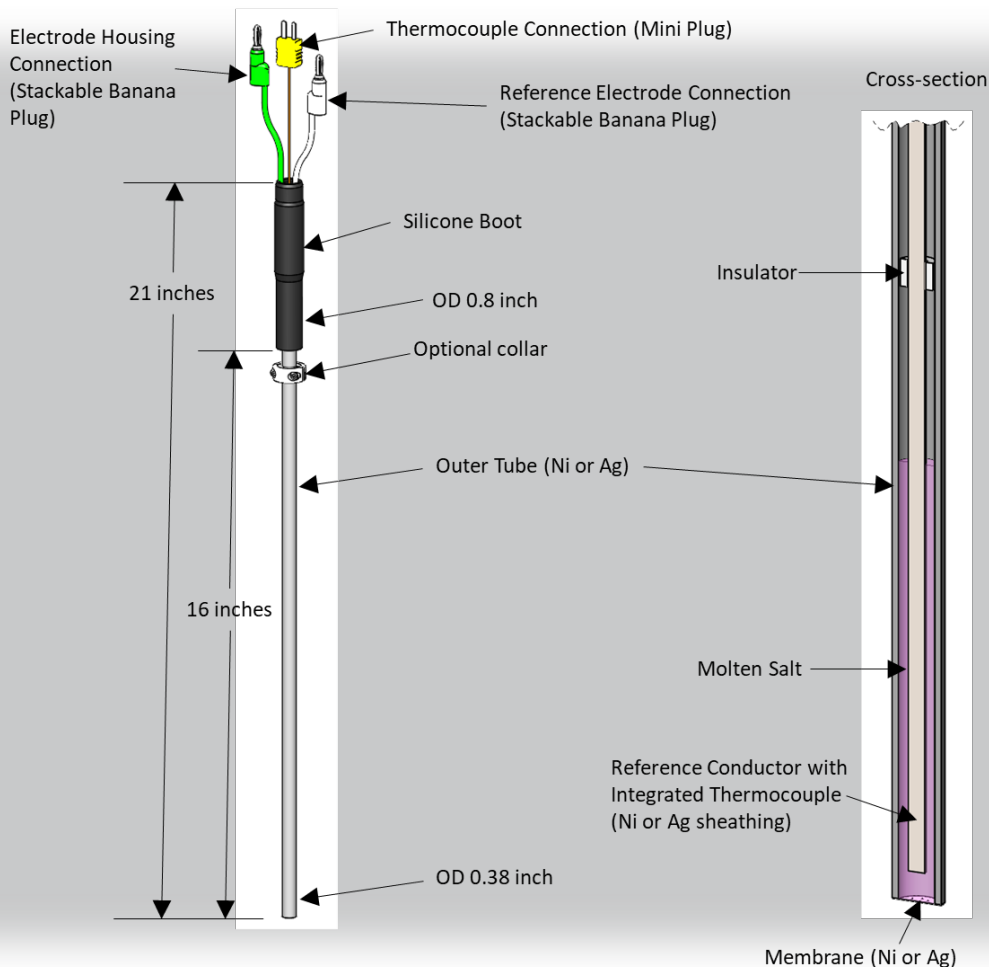
1. Robust, Standardized High-Temperature Molten Chloride Salt Reference Electrodes, DE-SC0021439
<https://www.sbir.gov/sbirsearch/detail/2056865>
2. Stable High-Temperature Molten Salt Reference Electrodes, DE-SC0020579
<https://www.sbir.gov/sbirsearch/detail/2104123>
3. "Robust and Standardized High-temperature Molten Chloride Salt Reference Electrode," 2022 TMS Annual Meeting & Exhibition
4. "Long Term Stability of Ag/AgCl Reference Electrode in Molten Chloride Salt," Log 254, 12th International Conference on Methods and Applications of Radioanalytical Chemistry 2022



**HiFunda can help to solve your greatest
electrochemical and materials challenges**

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Customized HTREs for Your Molten Salt Applications



HTRE Type	Reference Wire	Housing	Membrane	Reference Melt	Wire Length (inches)	Thermocouple	HTRE length (inches)	Max Use T (°C)	Immersion Depth (Inches)	Interface	Part No.
Ag/AgF	Ag99.9	Ag99.9	Ag99.9	AgF/FLiNaK	36	Type K	21	750	4	Collar	Ag/AgF-1112-123-222-1111
Ni/NiF ₂	Ni201	Ni201	Ni201	NiF ₂ /FLiNaK	36	Type K	21	750	4	Collar	Ni/NiF ₂ -2223-223-222-1111
Ag/AgCl	Ag99.9	Ag99.9	Ag99.9	AgCl/MgCl ₂ , NaCl, KCl	36	Type K	21	750	4	Collar	Ag/AgCl-1112-323-222-1111
Ni/NiCl ₂	Ni201	Ni201	Ni201	NiCl ₂ /MgCl ₂ , NaCl, KCl	36	Type K	21	750	4	Collar	Ni/NiCl ₂ -2223-423-222-1111

HTRE Customization Options

Feature	Description	1	2	3	4	5	6	7	8	9	Comments
A	Reference conductor	Ag99.9	Ni201	other customer specified (OCS)							Options highlighted in green correspond to standard Ag/AgF HTRE
B	Housing	Ag99.9	Ni201	OCS							
C	Membrane type	Ag99.9	Ni201	Mullite	MgO	OCS					Mullite and MgO are not compatible with fluorides
D	Membrane leak rate (MLR, secm)	0.0	0.1		1	10	OCS				Ni, Ag, and MgO MLR can be customized. Mullite MLR = 0
E	Reference melt	AgF/FLiNaK	NiF ₂ /FLiNaK	AgCl/Chloride solar salt (Future2B)	NiCl ₂ /Chloride solar salt (Future 2b)	Nitrate solar salt (Future2B)	AgF/FLiBe (CDS)	OCS			Test melt plus reference salt
F	Reference salt composition (mol%)	0.1	1	100	OCS						Reference salt = AgF, NiF ₂ , AgCl, or AgNO ₃
G	Wire length (inches)	12	24	36	OCS						
H	Thermocouple Type	None	K	N							
I	Immersion depth (inches)	2	4	6	8						Immersion depth and total length are linked.
J	Total HTRE length (inches)	19	21	23	27						Total length is linked to maximum use temperature
K	HTRE Interface	SS316 collar for height adjustment	Isolated swagelok fitting	Nonisolated swagelok fitting							OCP of HTRE housing independent of piping OCP when isolated and the same as piping when OCP not isolated
L	Characteristic CV	T=550°C	T=650°C	T=750°C							CV at 550°C included with 3 sweeps, additional cost for other temperatures
M	Verification testing	0	1	12	24	100					Additional cost for verification testing (~\$100/hr)
N	CofC	Not required	Required								Additional cost for CofC (~\$50)
O	Custom development services (CDS) available to benchmark or optimize the RE for each customer's salt mixture of interest										
P	Turnkey services available to design and build HT electrochemical test setups										



HiFunda works with customers to solve their most demanding technical challenges to develop and commercialize new materials and technologies

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