



“NOVEL TECHNOLOGIES FOR ENHANCED ENERGY AND EXERGY EFFICIENCIES IN PRIMARY ALUMINIUM PRODUCTION INDUSTRY”



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A. Bauxite Residues Treatment

Problem: Alumina Refineries produce Bauxite Residues (BR) at an almost 1:1 mass ratio to alumina. Global average annual production of BR is 120 million tones.



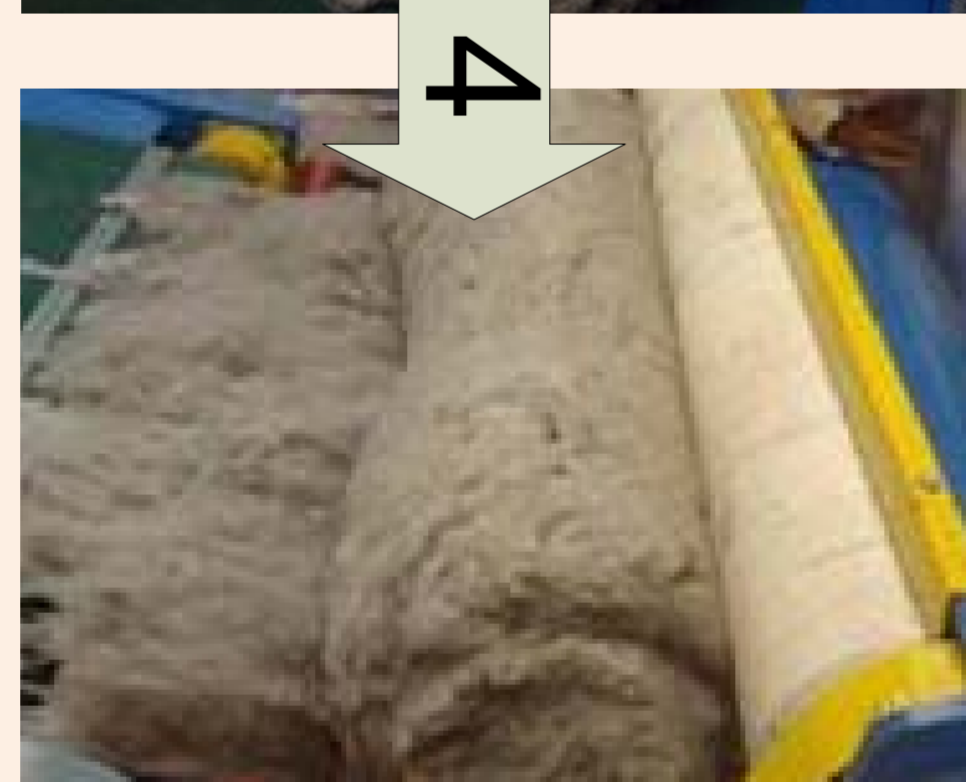
1. Dry Bauxite Residues (BR) are treated with carbon and fluxes in Electric Arc Furnace (EAF)



2. An aluminosilicate slag and pig-iron metal phase are produced



3. The slag is fiberized in-situ; the metal is cast in ingots and sold to secondary steel mills



4. Final products: **Mineral wool** products and secondary **steel products**

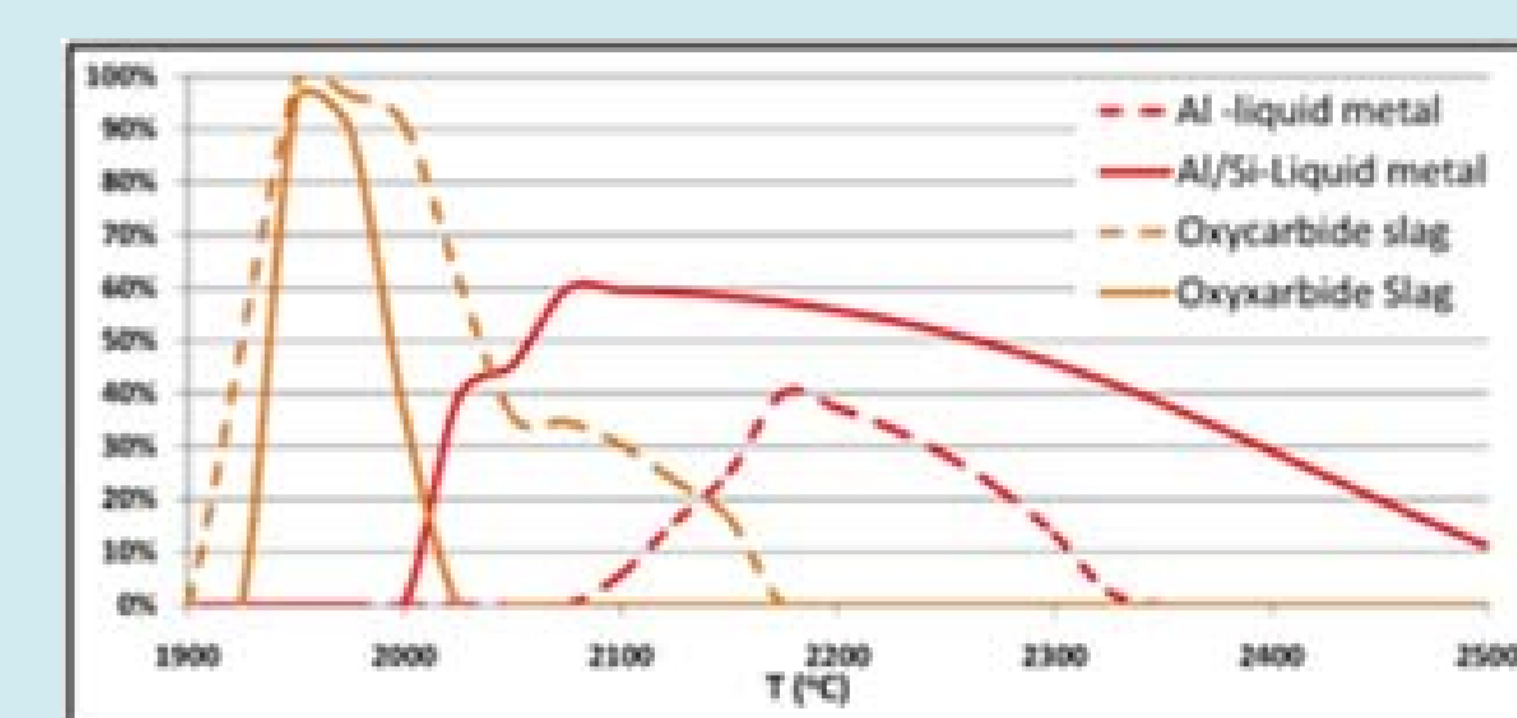
Result: 100% BR utilization at industrial scale

Photos from the ENEXAL pilot plant set up in Aluminon of Greece. Steel mill balls produced in Guca foundry in Serbia from 21% wt BR-pig iron

C. EAF Carbothermic production of Al-Si Master alloys

Problem: Carbothermic production of liquid Aluminum faces great challenges due to high temperature, carbide formation and Al-vaporization losses.

Solution: Introduce silicon into the system to reduce activity of carbide and vapor phases



Alumina+Silica+

Carbon pellets



EAF processing



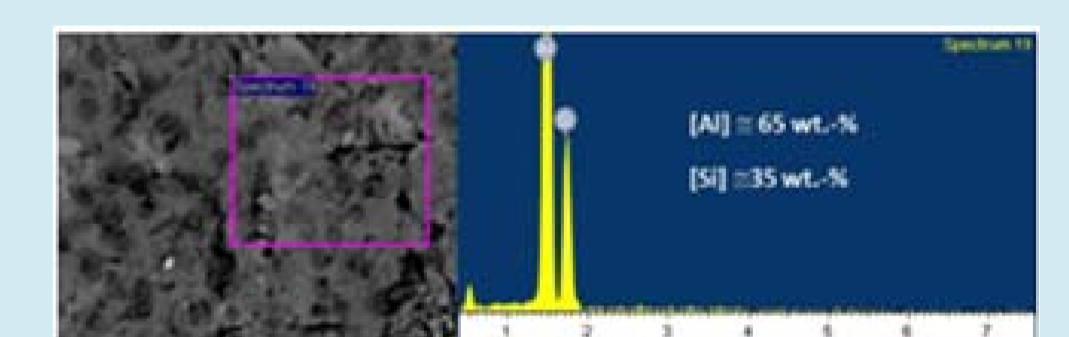
Al-Si Block

Photos from the RWTH-Aachen IME laboratory EAF and produced Al-Si blocks



Al-Si Refined

Sample ID	Al	Si	Fe	Mn	Ca	C	Other
(1)	65.22	34.4	0.20	0.05	0.02	0.03	< 0.05
(2)	63.83	35.62	0.26	0.05	0.03	0.15	< 0.05
(3)	62.78	36.82	0.22	0.05	0.02	0.05	< 0.05
(4)	63.61	36.12	0.20	0.05	0.02	0.01	< 0.05
Al-Si Master alloy	Si	Max Fe	Max Mn	Max Ca	Max Others (each)		
AlSi25	23-27	0.40	0.15	0.10			0.05
AlSi50	47-53	0.50	0.15	0.15			0.05

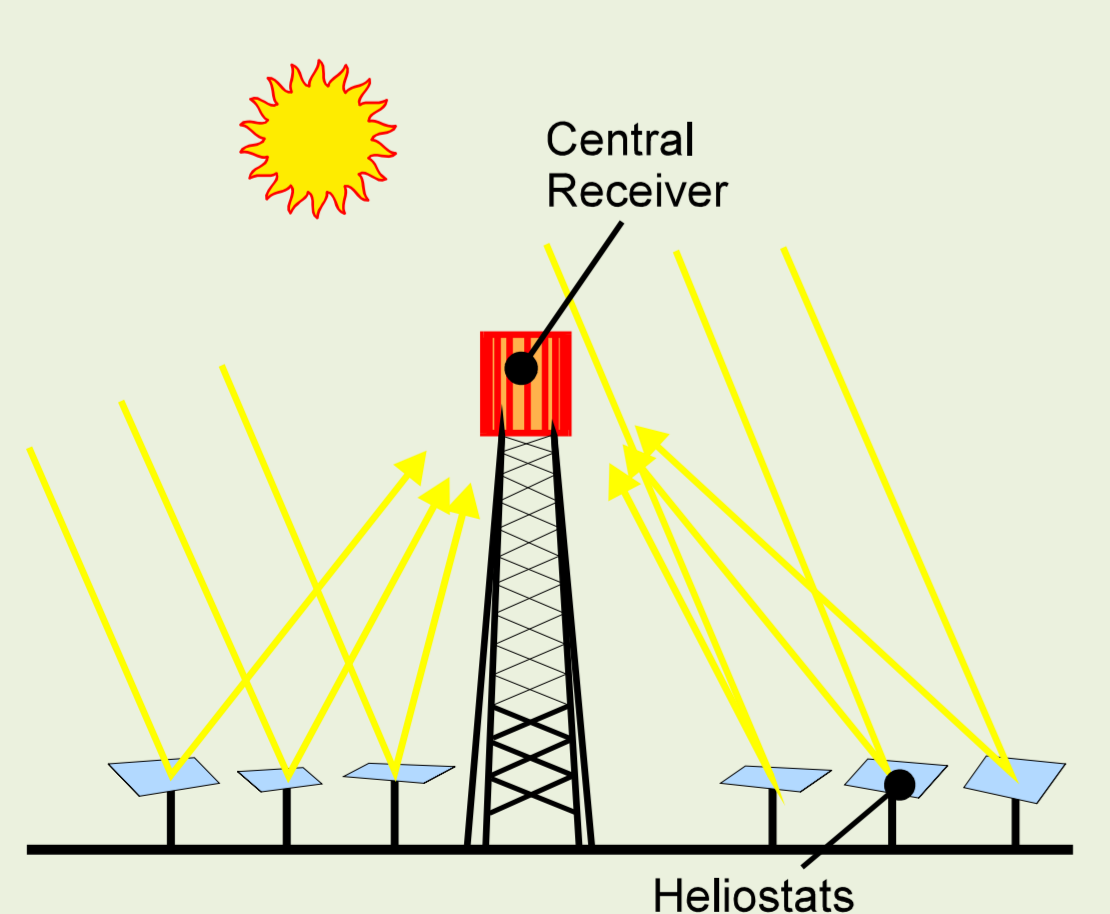
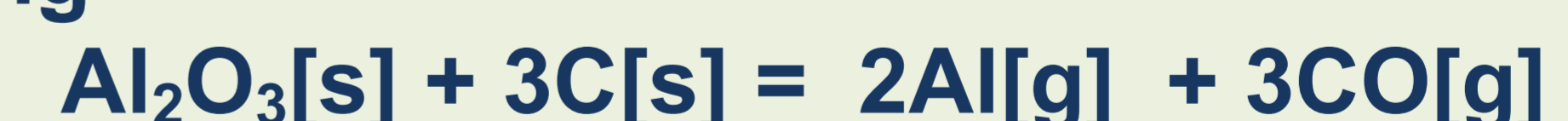


Result: Al-Si master alloy can be directly produced; Al-Si casting alloys represent 30% of the total Al market.

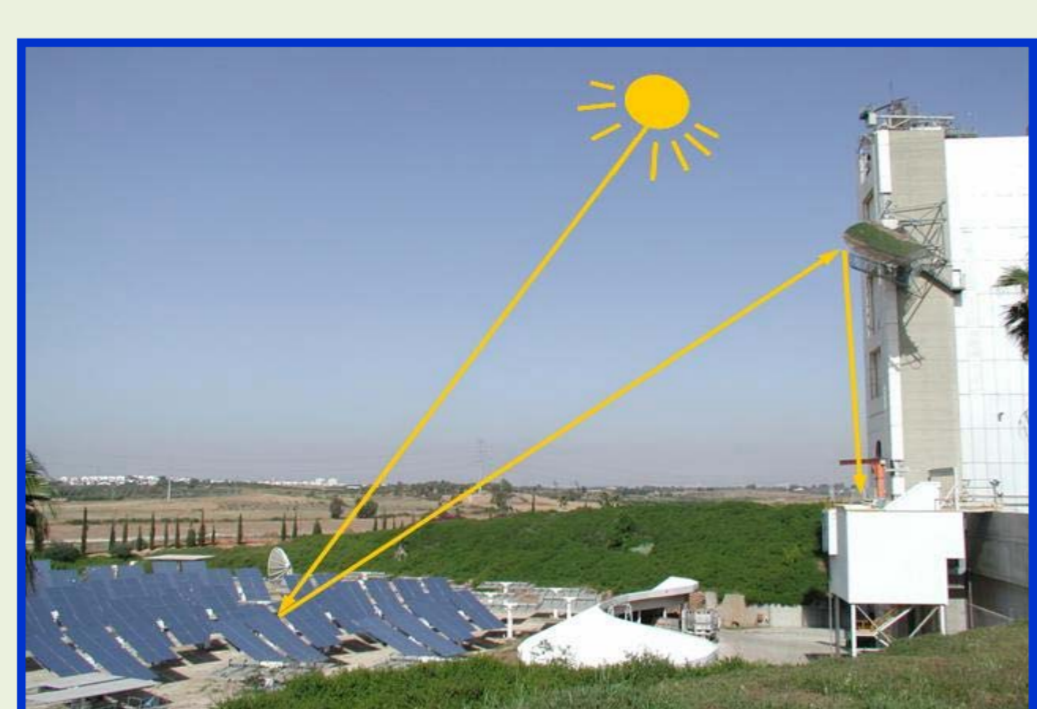
B. Alternative Aluminum production – Solar Furnace

Problem: Primary Aluminum production is performed today through molten salt electrolysis, in one of the most energy and carbon intensive industrial process.

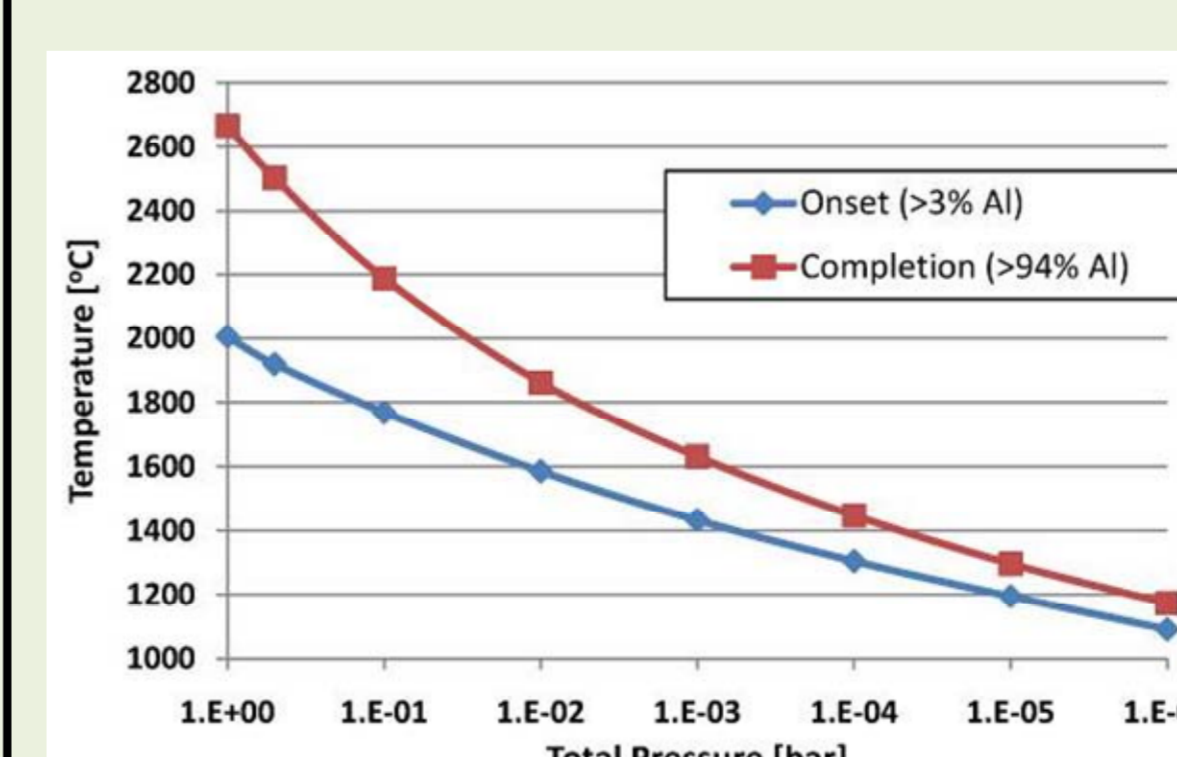
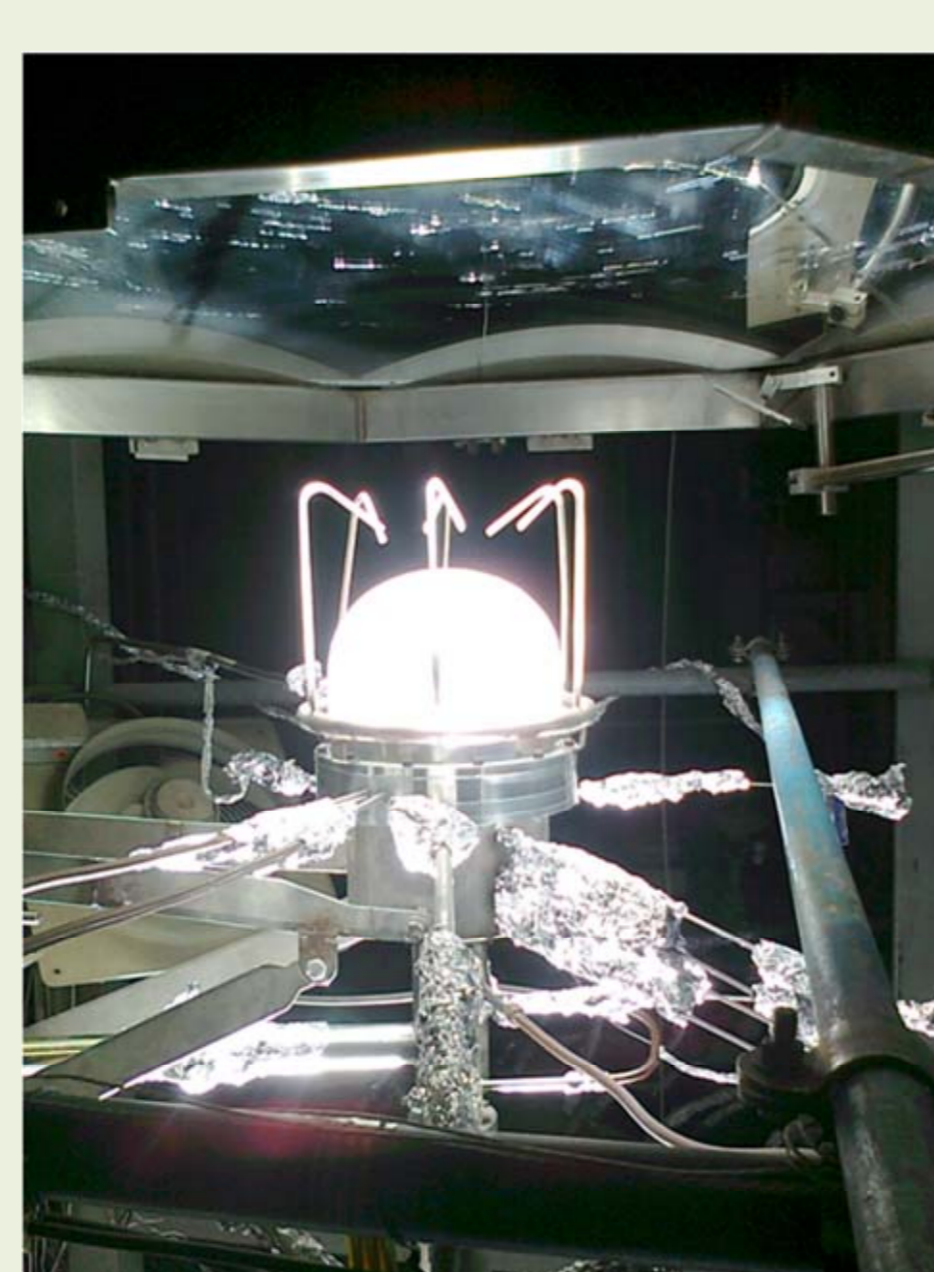
Solution: Move to Carbothermic alumina reduction processing



The Solar Furnace uses concentrated solar radiation to provide process heat

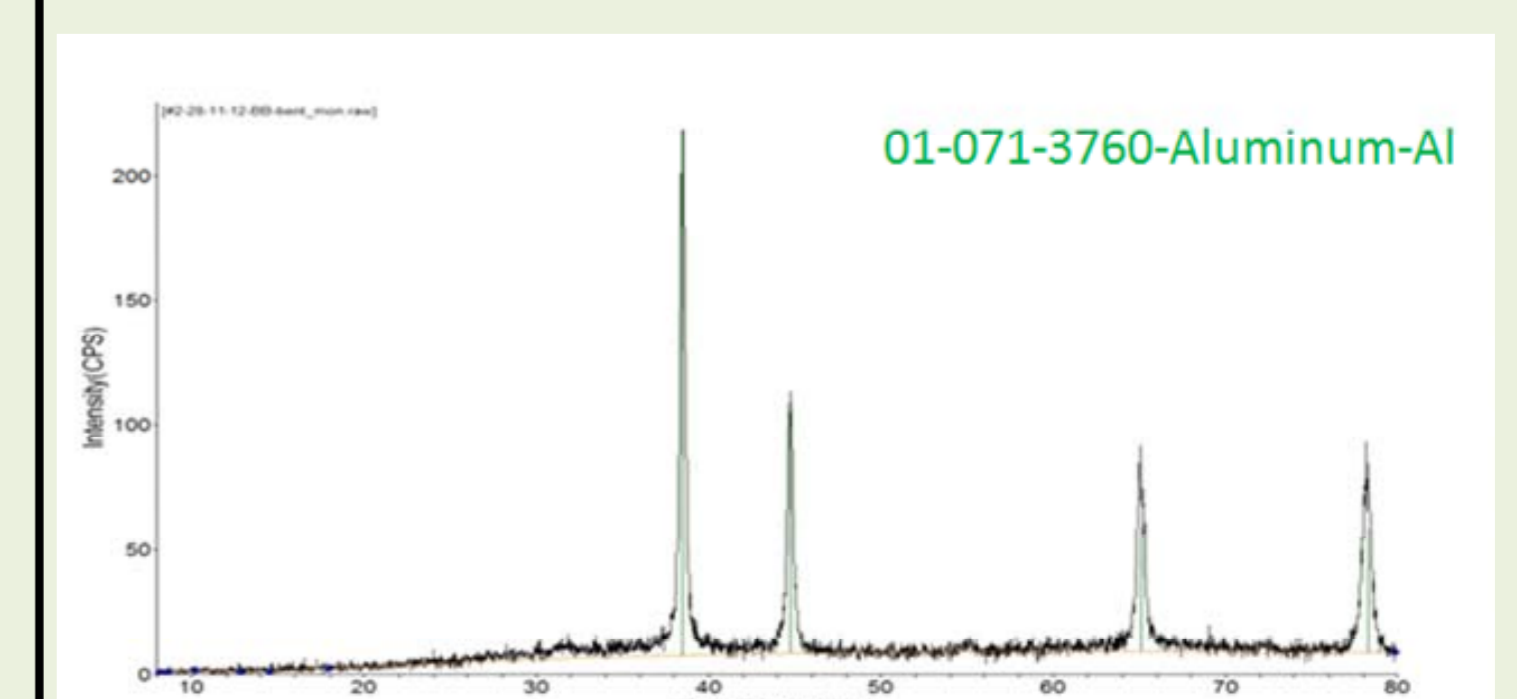


Photos from prototype solar furnace installed in Weizmann Institute of Science in Israel



Vacuum pumps reduce the temperature needed for the reaction

Al vapors are recovered in condensers before back-reactions occur



Result: Solid Al has been produced in solar furnace.



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