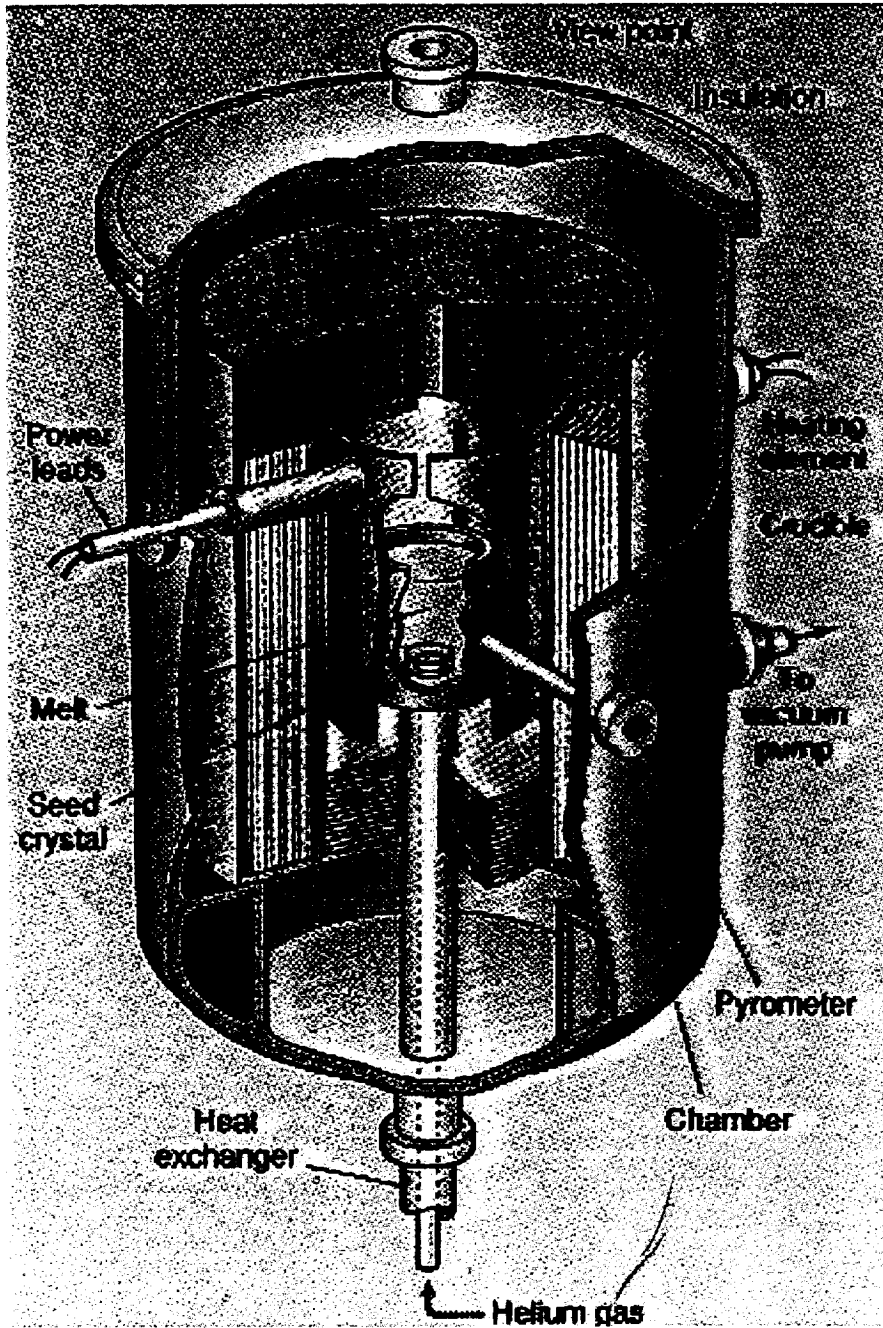


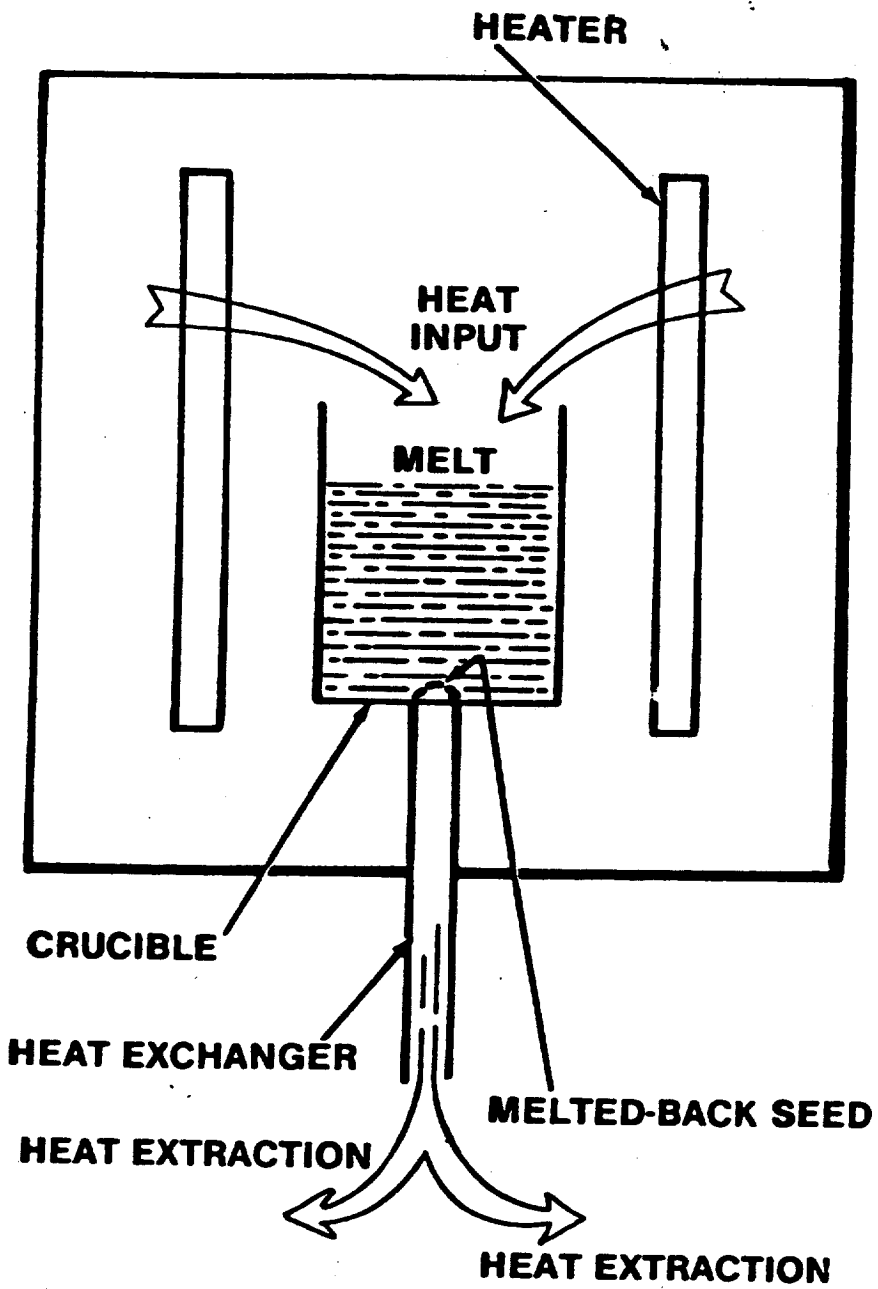


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A schematic of an HEM furnace.

HEAT FLOW DIAGRAM



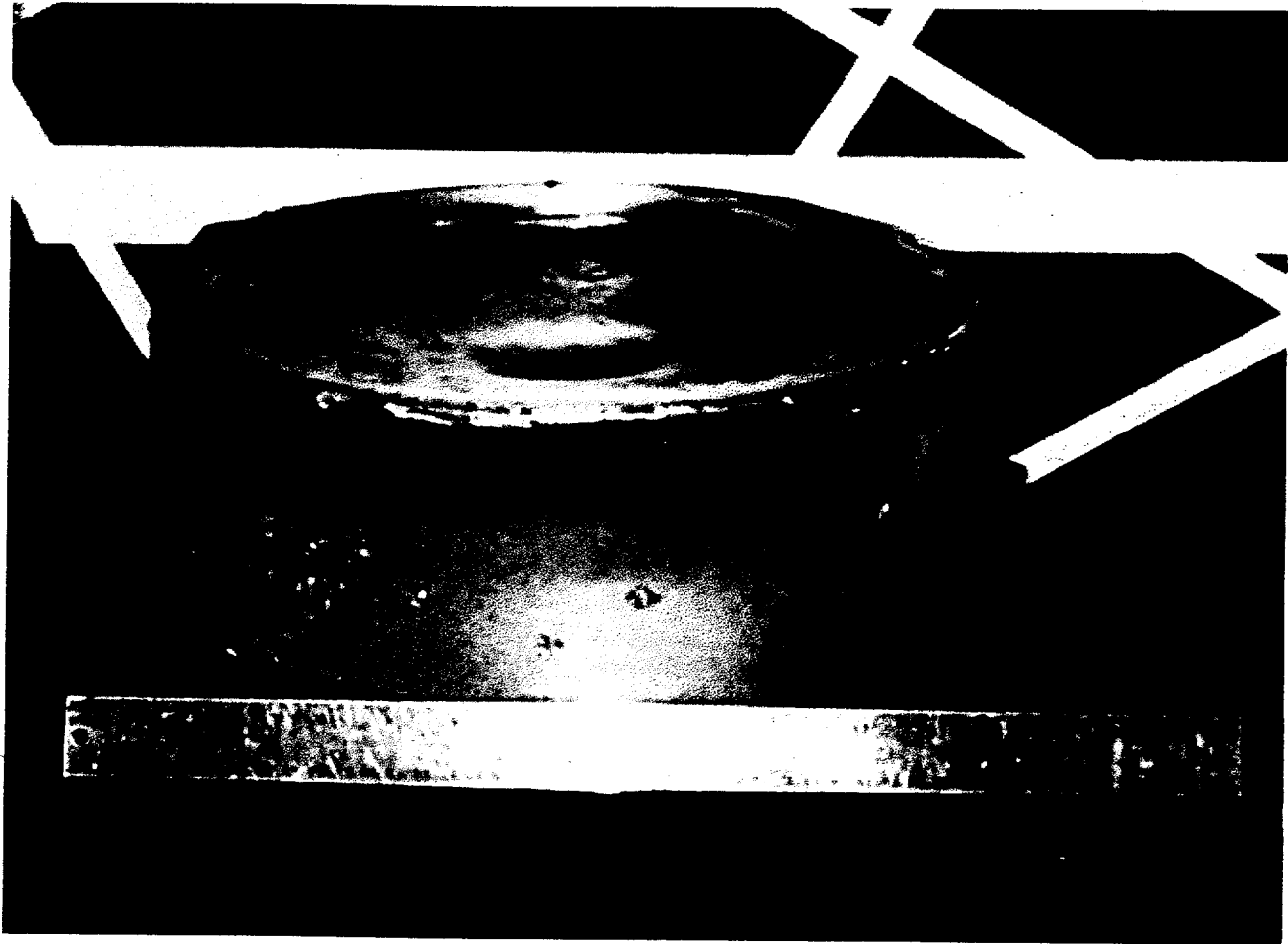


Advantages of HEM

- Control of a single crystal growth process
- Stabilizing temperature gradients
- Minimize convection
- No stirring of melt
- No rotation of the crucible
- Ability to control shape of solid-liquid interface during growth
- Last material to solidify is along crucible wall
- Good rejection of impurities
- Simple



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13" Diameter HEM Sapphire Boule

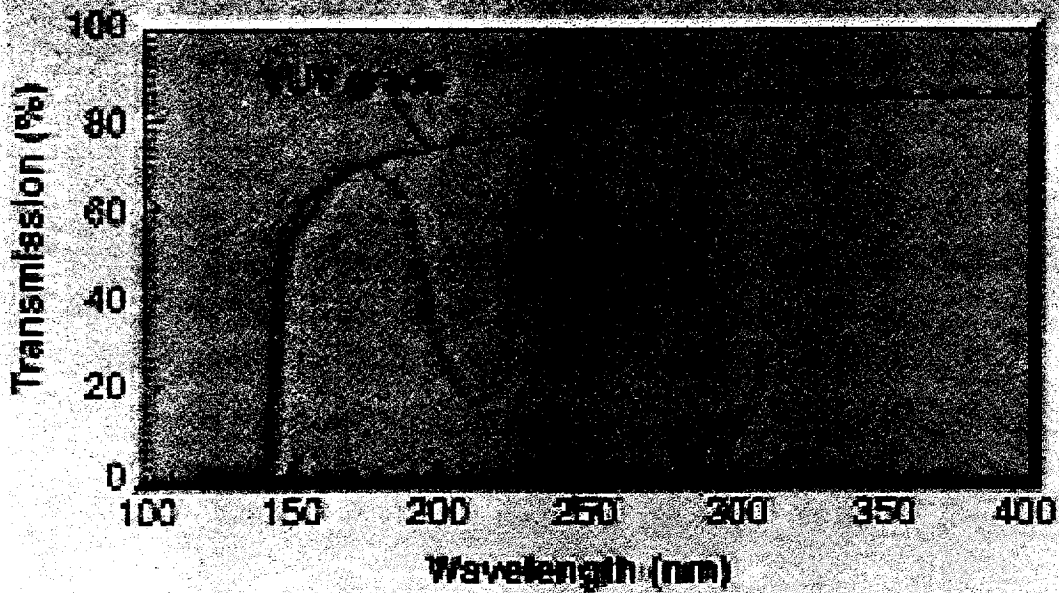
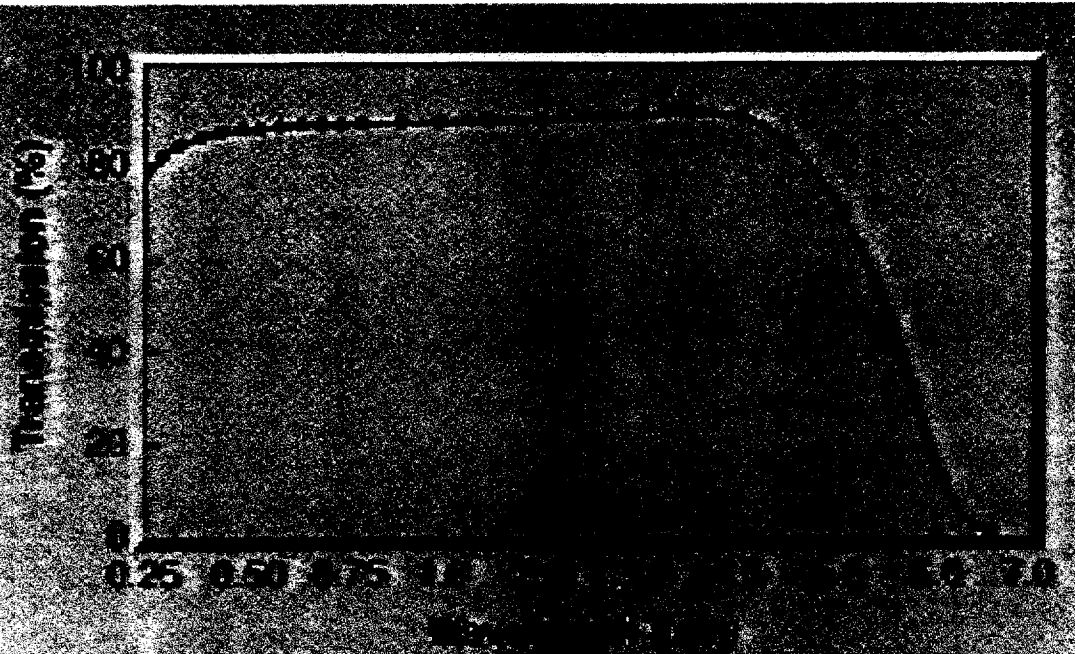


WINDOW REQUIREMENTS

- High optical transmission
- High abrasion resistance
- Minimal optical scatter
- High refractive index uniformity
- Large size



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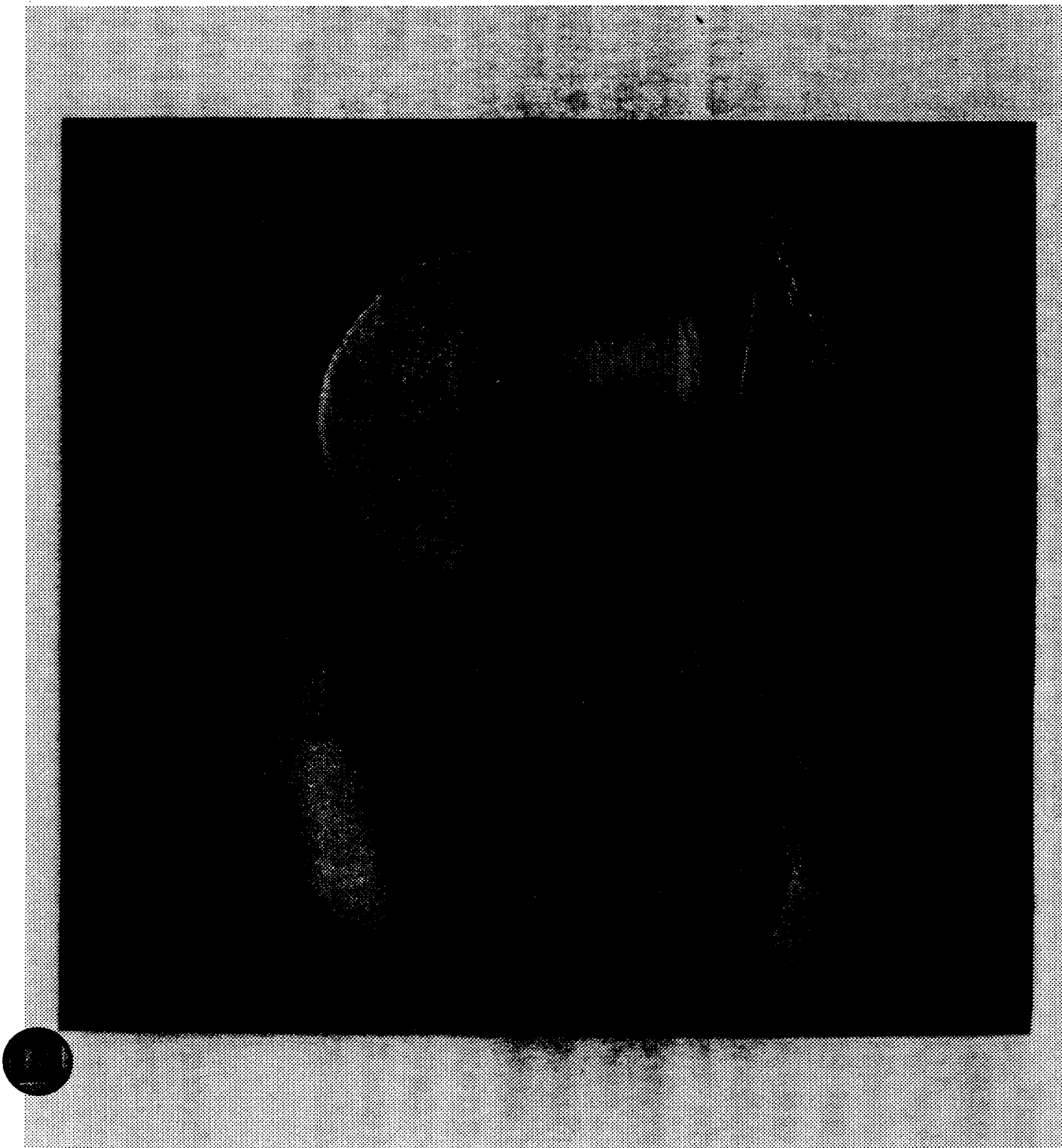


Anisotropic Properties

Crystal Orientations

- $[0001]$ - c -axis - 0°
- $[11\bar{2}0]$ - a -axis - 90°
- $[10\bar{1}0]$ - m -axis - 90°
- $[\bar{1}102]$ - r -axis - 60°

Non-Uniform Thermal Expansion





High Melting Point

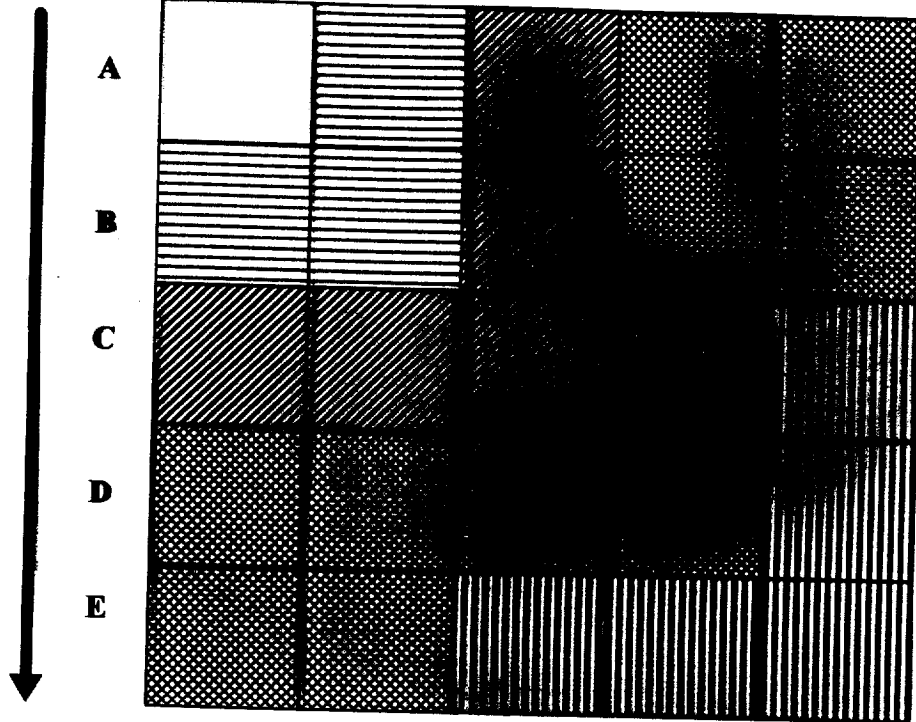
- Melting Temperature - 2040°C
- Sapphire Vapor
- Formation of Suboxides
- Reaction with Heat Zone
- Degradation of Heat Zone

Light Scatter



1 2 3 4 5

Lattice Distortion



Hemex



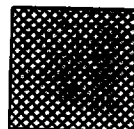
Hemlite



Hemlux



Hemcor



Hemverneuil



Transmitted wavefront distortion data for various grades and orientations of sapphire samples

Sample	Orientation	ID	Grade	Homogeneity	Homogeneity, rms	PV (Wave)
	(11 $\bar{2}$ 0)	10	Hemex	2.78349E-06	3.340857E-07	0.041
	(11 $\bar{2}$ 0)	9	Hemlux	3.41919E-06	4.347430E-07	0.051
	(11 $\bar{2}$ 0)	7	Hemlite	3.05817E-06	3.660218E-07	0.045
	(11 $\bar{2}$ 0)	8	Hemcor	5.11889E-06	5.744561E-07	0.076
	(11 $\bar{2}$ 0)	6	Hemverneuil	4.21734E-06	6.179205E-07	0.063
	(0001)	5	Hemex	1.47575E-06	1.867685E-07	0.022
	(0001)	3	Hemlux	1.68367E-06	2.175566E-07	0.025
	(0001)	1	Hemlite	3.05309E-06	4.535550E-07	0.046
	(0001)	4	Hemcor	3.83489E-06	6.469233E-07	0.058
	(0001)	2	Hemverneuil*	9.40220E-06	7.169225E-07	0.141

*This sample had a severe localized lattice distortion, and it was included in the analysis.

Note 1, Linda Turner, 08/17/99 08:03:21 PM
LIGO-G990079-20-M