

Material Selection for the Masses and Wires (1)

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Material Selection for the Masses

Objective

- Material Selection for the Upper Mass, Recoil Mass for the mirror, and some other parts.
- Environment Condition:
 - 15-20K. UHV.
 - Weight and size must be almost the same with its counterweight (~30kg per item).
 - Will be coated in black to avoid thermal scattering and stray lights.

Required Specifications

- Physical Properties
 - 1) Higher Thermal Conductivity (Reducing thermal road, promoting thermal diffusion)
 - 2) Larger Young's Modulus (Reducing Internal Oscillation)
 - 3) Smaller Specific Heat (Saving cooling power)
 - 4) Smaller Residual Resistivity Ratio (Avoid Eddy Current Dumping)
 - 5) Smaller Magnetism (Prevent being attracted by magnets)
 - 6) CTE (No specific requirement?)
- Others
 - 7) Machineability (Alloy is better)
 - 8) Availability (huge bulk, ~100kg, solid?)
 - 9) Price
- Learn from Other Instrument's experience?

CLIO is much smaller than LCGT. LIGO and VIRGO are not operated in a cryogenic.

Properties at Cryogenic Environment

	Density [E+3 kg/m ³]	Thermal Conductivity [W/m/K]	Young's Modulus [GPa]	Specific Heat [J/kg/K]	Resistivity [uΩm]	CTE [E-6/K]
Oxygen Free Copper	8.9	~3000@4.2K ~2000@30K ~460@100K ~395@300K	0.35@300K	96@50K 255@100K 389@300K	See figure.	1.0@30K 10.7@100K 18.3@300K
Beryllium Copper	8.25	130@300K		233@300K		17.5@300K
Tellurium Copper	8.94	356@300K		385@300K		
Al6061-T6	2.71	71@60K 98@100K 159@300K	0.33@300K	~10@20K ~80@100K 960@300K	~0.02@20K ~0.04@300K	24@300K
Ti6Al4V	4.43	~2@20K ~5@100K ~10@300K	0.342@300K	~8@20K ~130@100K	<0.01@5K ~2@20K ~2@300K	8.8@300K
Silicon	2.33	2680@50K 884@100K 168@273K	Anistropic.	700@300K?		0.5@100K 1.5@200K 2.6@293K

Material Selection for the Wires

- Suspension wires for the masses. Expected little as a thermal path.

- Conditions
 - 15-20K. UHV.
 - Used with a couple of wires, suspend the mass from the upper mass.

- Required Specifications
 - 1) Light Weight (Reducing Violin-mode)
 - 2) Larger Young's Modulus
 - 3) Stronger Tensile Strength (Prevent cutting off)
 - 4) Higher Q Factor (Stable Oscillation)

- Candidates and their Issues
 - * Tungsten: kink
 - * Stainless Steel: Magnetism

Properties of Wires at Cryogenic Environment

*Room Temp	Density [E+3 kg/m ³]	Thermal Conductivity [W/m/K]	Tensile Strength [MPa]	Young's Modulus [GPa]	Resitivity [uΩ/m]	
Tungsten						
SUS?						
Ti6Al4V						
Bolfur (0.1mmD)	7.6		~3500	156.8	140	

Future Works

- Search vendors.
- Experimentally confirmation (RRRs, thermal conductivities, and some other parameter).
- Feedback to designing and simulations of the payload.