SSC-N-184

# Measurement of Residual Resistivity Ratio in the presence of a Magnetic Field for Various Copper Platings of Stainless Steel Beam Tubes

D. Bintinger
SSC Central Design Group

May 29, 1986

Introduction: If a stainless steel beam pipe is used for the SSC, it will be necessary to plate the inside of the beam pipe with a thin layer of some high conductivity material to reduce resistive wall impedance and, in particular, the parasitic heating. Copper has been chosen for this plating material. The conductivity of the copper is usually given by residual resistivity ratio (RRR), that is, the ratio of the resistivity at room temperature to the resistivity at 4 °K. This note presents RRR measurements for various copper platings at magnetic fields ranging from 0 to 6 Tesla.

Data: Table I presents RRR readings for sample copper platings as a function of magnetic field. All data were taken by Ron Scanlan of LBL. The plating was done by PCK of Long Island, New York. The error on the RRR measurements due to the accuracy of the measuring apparatus is estimated to be ±10%. The anodes listed under the plating column are those used in the plating process.

Table I

RRR vs. Magnetic Field for Various Copper Platings

| Plating | Thickness | RRR Values | | | |
|---|---|---|---|---|---|
| | | 0 Tesla | 2 Tesla | 4 Tesla | 6 Tesla |
| pure copper (perhaps annealed, copper anode) | 0.008" | 747 | 132 | 77 | 56 |
| pure copper (Pt-Ti anode) | 0.008" | 908 | 119 | 70 | 51 |
| pure copper (electropolished, Pt-Ti anode) | 0.008" | 474 | 106 | 63 | 46 |
| pure copper (Pt-Ti anode) | 0.004" | 513 | 208 | 126 | 91 |
| pure copper (pulsed current, Pt-Ti anode) | 0.004" | 1018 | 252 | 149 | 108 |
| PC Glean (a commercial printed circuit copper plating solution, Pt-Ti anode) | 0.004" | 109 | 88 | 70 | 58 |

Remarks: All the RRR values at 6 Tesla exceed the value of 30 assumed in the Conceptual Design Report. The magnitude of the eddy currents during quench and the resultant mechanical forces on the beam tube are directly proportional to RRR and plating thickness. Thus given the RRR values of Table I, a plating thickness must be chosen to satisfy the low wall impedance requirement and yet not so thick as to produce unnecessary forces on the beam tube during quench. The current plating thickness of 4 mils was chosen with an RRR of 30 in mind. A plating thickness of 2 mils now looks acceptable from the point of view of impedance. The thickness of the stainless steel beam tube wall necessary to withstand the forces during quench is currently under consideration.

The last entry in Table I is for plating done using a cheap commercial plating bath named PC Glean. While the RRR at magnetic field equal zero is lower than the pure copper platings, the RRR at 6 Tesla is comparable to the pure copper platings. However, other properties of commercial plating solutions (e.g. outgassing, desorption) may rule these solutions out. Also the cost of the plating bath is not a major fraction of the total plating cost.