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The Problem of Obtaining a Metastable Modification of Thallium

E. I. Abaulina and N. V. Zavaritskii
Institute for Physical Problems,
Academy of Sciences, USSR

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An explanation as to the role played by the crystal lattice in the phenomenon of superconductivity may be found in various studies of the crystalline modification of one or another of the substances at low temperatures. In three well-known metals, thallium, titanium and zirconium, the α-modification exhibits superconductivity but β- modification has not been investigated at low temperatures.

One of the methods yielding a high temperature modification in metastable form is that of sudden quenching. This method of quenching pure substances has been treated by Sekito [1]. In this work an x-ray investigation was made of the modification of thallium (prepared by Kal'baum) which had received rapid cooling of the metal in ice water . As is known, at 235 °C, thallium undergoes allotropical changes in which the density due to hexagonal close packing changes to that of a body centered cubic[2] . Due to this quenching[1] the sample now exhibits a face centered lattice structure.

We have undertaken a low temperature study of the metastable modification of thallium (99.98% pure). The desired quenching may be achieved by several methods:

1. Thallium melted in a glass tube over a Bunsen-burner and plunged into ice water (method of reference 1).

2. To avoid crystallization of melted thallium in the α-modification, stable at 0 °C, the sample before quenching is slowly cooled in the oven from melting temperature (303 °C) to 290 °C. The sample is prepared by melting thallium in thin walled capillary tubes having a wall thickness of 0.1 mm.

3. For very rapid quenching the melted thallium is poured out under vacuum on a copper surface cooled to the temperature of liquid air.

Immediately after the preparation of the sample, x-ray analysis followed. It appears that x-ray analysis does not reveal any difference between the quenched sample and that of ordinary thallium. This likewise applies to the measured magnetic moment of the samples at the liquid temperature of helium. In all samples, in quenched as well as in unquenched, the transition to the superconducting state was observed at 2.38-2.4 °K. The marked absence of hysteresis (less than 1%) and the abrupt transition from superconductivity to the normal state is evidence of the absence of impurities occluded in the sample.

Analysis of the results of these methods shows that not one of the above methods lends itself to producing the thallium in metastable modification as in contrast of the statements found in reference 1. Thus the question of quenching pure thallium is left open.

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Possible Methods of Obtaining Active Molecules for a Molecular Oscillator

N. G. Basov and A. M. Prokhorov
P. N. Lebedev Institute of Physics,
Academy of Sciences, USSR

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As was shown in reference 1, one must use molecular beams in order to make a spectroscope with high resolving power. In this reference the possibility of constructing a molecular oscillator was investigated. Active molecules needed for self-excitation in the molecular oscillator were to be obtained by deflecting the molecular beam through inhomogeneous electric or magnetic fields. This method of obtaining active molecules has already been employed in the construction of a molecular oscillator [2]