World Academy of Science, Engineering and Technology
International Journal of Physical and Mathematical Sciences
Vol:18, No:10, 2024

The Unique Electrical and Magnetic Properties of Thorium Di-Iodide Indicate the Arrival of Its Superconducting State

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Abstract : Even though the recent claim of room temperature superconductivity by LK-99 was confirmed an unsuccessful attempt, this work reawakened people's century striving to get applicable superconductors with Tc of room temperature or higher and under ambient pressure. One of the efforts was focusing on exploring the thorium salts. This is because certain thorium compounds revealed an unusual property of having both high electrical conductivity and diamagnetism or the so-called "coexistence of high electrical conductivity and diamagnetism." It is well known that this property of the coexistence of high electrical conductivity and diamagnetism is held by superconductors because of the electron pairings. Consequently, the likelihood for these thorium compounds to have superconducting properties becomes great. However, as a surprise, these thorium salts possess this property at room temperature and atmosphere pressure. This gives rise to solid evidence for these thorium compounds to be room-temperature superconductors without a need for external pressure. Among these thorium compound superconductors claimed in that work, thorium di-iodide (ThI_2) is a unique one and has received comprehensive discussion. ThI_2 was synthesized and structurally analyzed by the single crystal diffraction method in the 1960s. Its special property of coexistence of high electrical conductivity and diamagnetism was revealed. Because of this unique property, a special molecular configuration was sketched. Except for an ordinary oxidation of +2 for the thorium cation, the thorium's oxidation state in ThI_2 is +4. According to the experimental results, ThI_2's actual molecular configuration was determined as an unusual one of [Th4+(e-)2](I-)2. This means that the ThI_2 salt's cation is composed of a [Th4+(e-)2]2+ cation core. In other words, the cation of ThI_2 is constructed by combining an oxidation state +4 of the thorium atom and a pair of electrons or an electron lone pair located on the thorium atom. This combination of the thorium atom and the electron lone pair leads to an oxidation state +2 for the [Th4+(e-)2]2+ cation core. This special construction of the thorium cation is very distinctive, which is believed to be the factor that grants ThI_2 the room temperature superconductivity. Actually, the key for ThI_2 to become a room-temperature superconductor is this characteristic electron lone pair residing on the thorium atom along with the formation of a network constructed by the thorium atoms. This network specializes in a way that allows the electron lone pairs to hop over it and, thus, to generate the supercurrent. This work will discuss, in detail, the special electrical and magnetic properties of ThI_2 as well as its structural features at ambient conditions. The exploration of how the electron pairing in combination with the structurally specialized network works together to bring ThI_2 into a superconducting state. From the experimental results, strong evidence has definitely pointed out that the ThI_2 should be a superconductor, at least at room temperature and under atmosphere pressure.

Keywords : co-existence of high electrical conductivity and diamagnetism, electron lone pair, room temperature superconductor, special molecular configuration of thorium di-iodide ThI_2

Conference Title : ICUSM 2024 : International Conference on Unconventional Superconductivity and Magnetism

Conference Location : Barcelona, Spain

Conference Dates : October 24-25, 2024