^{15}N Needles in the Haystack for Near Ambient Superconductivity: Possible ^{15}N Enrichment at Lower Temperatures and Pressures

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Abstract

The author has previously noted the effects of stable isotopes having different nuclear magnetic moments on chemistry, catalysis, biochemistry, thermodynamics, optics, superconductivity and more [1]. In this controversy surrounding reported room temperature superconductivity at near ambient pressures by nitrogen doped lutetium hydride, the author hopes to convince and reason that the different synthesis conditions of the original work of Dias and coworkers [2] at low temperature, mild pressures, diamond anvil cell compression and prolong annealing may lead to selective doping of the lutetium hydride by ^{15}N. The later attempted replication of Dias and coworkers by Hai-hu Wen and coworkers [3] may have caused different outcomes as Hai-hu Wen and coworkers appeared to try Dias work and then switched to a different synthetic method whereby Wen and coworkers instead applied high pressures and high temperatures to the reacting hydrogen, nitrogen and lutetium to produce a nitrogen doped lutetium hydride with similar lattice structure as the originally reported by Dias and coworkers [2] but lacking observed superconductivity and evidence of superconductivity by diamagnetism. The author here by his theory notes the possibility that the different later high pressure, high temperature synthesis by Wen and coworkers doped their sample with ^{14}N rather than ^{15}N as originally enriched in Dias's sample. Thereby the author notes by his theory [1] that whereas ^{15}N doped lutetium hydride manifests higher superconductivity due to its negative nuclear magnetic moment (NMM), the ^{14}N doped lutetium hydride should not manifest superconductivity at the higher temperatures due to its positive NMM.

The Unique Role of Hydrogen Due to Its Lack of Core Electrons

Hydrogen lacking core electrons interacts in presence of other protons in dense protons by altering electrons of Cooper pairs to produce negative magnetic moments to bind the protons and by such action of the protons the electrons superconduct. The dense protons induce backward or dark (Dk) motions of electrons for assisting superconductivity. The protons interact with the Copper pairs to prevent their dissipations of energy for sustaining superconductivity at higher temperatures.

The Lutetium and Its Role by its filled 4f subshell

The 4f electrons of the lutetium experience to protons to host the superconductivity. The ungerard symmetry of the p and f subshells by the authors theory provides both Br and Dk symmetry for chirality for superconductivity.

The Role of ^{15}N for Supporting Higher Superconductivity

The ^{15}N has negative NMMs and by the author's theory [1] the NMM provides nuclear pressure for backward motions of the electrons for supporting superconductivity. In the presence of the ^{15}N, the superconductivity occurs at lower hydrogen content. The ^{15}N pulls the protons to denser interactions with the $e^- e^-$ Cooper pairs for preventing dissipations of the $e^- e^-$ pairs during conduction. ^{15}N pushes away $e^- e^-$ but pulls p^+. But unlike ^{15}N and its negative NMMs pulling p^+ and pushing $e^- e^-$ pairs away, ^{14}N has positive NMM and pushes protons away from ^{14}N and pulling $e^- e^-$ pairs to ^{14}N.

Different Syntheses of Dias and Wen and Different ^{15}N Enrichments

The original synthesis of Dias and coworkers [2] may more likely enrich and dope the forming lutetium hydride with ^{15}N and the attempted replication of Wen and coworkers [3] may less likely enrich and dope their lutetium hydride with ^{14}N. They form the same structure as dictated by the lutetium and hydrogen, but they have different isotopes of nitrogen. Dias originally synthesized the room temperature near-ambient pressure superconducting nitrogen doped lutetium hydride by compressing a gaseous mixture of hydrogen with 1% nitrogen with lutetium between two diamonds of a diamond anvil cells to pressure of 10,000 atm and warm temperature of 65 °C over night [2].

Wen's Attempted Replication

But Wen used different conditions of much higher pressures and higher temperatures upon nitrogen, hydrogen gaseous reactant with lutetium solid with laser heating [3]. Wen did not use diamond anvil cell, but they used "a piston cylinder type high pressure apparatus (LP 1000-540/50, Max Voggenreiter)". The chemistry employed by Wen and co-workers is different from Dias's original synthesis. Wen and coworkers perform a solid state high pressure synthesis by reacting:

$$2NH_2Cl\,(2) + CaH_2\,(s) \rightarrow CaCl_2 + 2NH_3 + H_2$$

These reactants are compressed into a solid pellet and mixed with separation by a BN with solid lutetium tablets and sealed inside a gold container. The resulting gold contained was placed inside a BN capsule and heated to 300 °C for 1 hours at 2 GPa (19,738 atm). These conditions are much different from the original conditions used by Dias. The starting materials are different as the reactants by Wen have different NMMs and the formed NH_3 is likely enriched with ^{14}N relative to ^{15}N due to positive NMM of proton and its lack of valence favoring ^{14}N over ^{15}N on the basis of Little's Effect. The positive NMM of ^{35}Cl and ^{37}Cl would favor it binding ^{15}N due to negative NMM of ^{15}N on the basis of Little's Effect. These reactions were performed in BN interface and Au container. The B and Au all have positive NMMs to favor interacting with ^{15}N and preventing ^{15}N release to NH_3 on basis of Little's Effect. These many factors would diminish the ^{15}N doping with the forming LuH_2.

Dias Original Synthesis

Dias did not report laser heating. The different conditions of lower pressures and temperature inside diamond anvil cell caused greater reactivity of the ^{15}N (due to its negative NMM) from N_2 in the ^{15}N and ^{14}N gaseous mixture of Dias for more ^{15}N atoms and $^{15}NH_y$ species for combining with Lu for selective doping of the forming lutetium hydride [2]. In the other hand, Wen and coworkers [3] used much higher temperatures and pressures with laser heating so the harsher conditions more activated ^{14}N from N_2 for ^{14}N doping the forming lutetium hydride. Dias originally synthesized the room temperature near-ambient pressure superconducting nitrogen doped lutetium hydride by compressing a gaseous mixture of hydrogen with 1% nitrogen with lutetium between two diamonds of a diamond anvil cells to pressure of 10,000 atm and warm temperature of 65 ^{o}C overnight [2]. The ^{1}H favors ^{14}N over ^{15}N by Little Effect. The ^{1}H favors the ^{14}N as the p^{+} has no valence electrons and the positive NMM of the proton acts directly on the e^{-} e^{-} of ^{14}N and the positive NMM of ^{14}N to more strongly bind the ^{14}N but more weakly bind ^{15}N and to release the ^{15}N. The ^{175}Lu and ^{176}Lu have positive NMMs and many core electrons and the Lu nuclei having many nucleons transform the nucleon moments in the nucleus to act differently than the bare p^{+} by Little Effect so the Lu favors binding ^{15}N and more ^{15}N is doped into the Lu. The lower temperature and lower pressures of Dias synthesis also favors ^{15}N as the ^{15}N-^{15}N triple bond is weaker relative to ^{14}N-^{14}N triple bond due to the negative NMMs of the ^{15}N and positive NMM of the ^{14}N by Little Effect. The ^{15}N is more inclined to combine with ^{1}H to chemically combine with Lu to form ^{15}N doped LuH_y.

Possible Similar Isotopic Effects for Carbonaceous Hydride Controversy

In considering the isotopic effects here, isotopic effects may give sound scientific basis for why researchers have had tough time replicating the carbonaceous hydride work of Dias [4]. Carbon has two stable isotopes in larger relative abundances: ^{12}C and ^{13}C. The ^{12}C makes up 99% of carbon by relative abundance on earth. ^{13}C makes up about 1% of the carbon on earth by relative abundance. During syntheses different synthetic conditions may enrich samples differently with ^{13}C for variation in superconducting properties and other properties made from different laboratories. The doping of sulfur hydride with ^{13}C is important as ^{13}C has nonzero positive NMM, but ^{12}C has null (0) NMM. The positive NMM of ^{13}C may contribute to superconductivity of the hydrogen sulfide.

References

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