Abstract Submitted to the NT05 NANOTUBE'05 Conference:

High-T_c Superconductivity in entirely end-bonded multi-walled carbon nanotubes

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One-dimensional (1D) systems face some obstructions that prevent the emergence of superconductivity, such as a Tomonaga-Luttinger liquid (TLL), spin fluctuation, small density of state due to van-Hove singularity, Peierls transition, and charge-density waves. A carbon nanotube (CN), an ideal 1D molecular conductor, is one of the best candidates for investigating this possibility. Although a variety of intriguing quantum phenomena has been reported in CNs, only two groups have reported intrinsic superconductivity with a transition temperature (T_c) as low as T_c = ~0.2K [1] and that identified only from the Meissner effect [2] in single walled CNs (SWNTs). No other studies reproducing these results have so far been reported. In addition, those correlations with 1D phenomena, particularly with TLL, which is a non Fermi-liquid state arising from an electron-electron interaction in 1D systems, have never been clarified. Here, we will present superconductivity with the onset temperature (T_c) as high as 12 K in multi-walled CNs (MWNTs), which were synthesized in nanopores of alumina templates [3]. This T_c is approximately 30-times larger than that in SWNT ropes [1]. We find that end-bonding of MWNTs by an electrode is crucial for realizing high-T_c superconductivity, because it makes contact to all of the shells possible and intershell effects lead to elimination of a TLL and growth of superconductivity.

[1] M. Kociak, A. Yu. Kasumov, H. Bouchiat, et al., Phys. Rev. Lett. 86, 2416 (2001)

[2] Z. K. Tang, L. Zhang, et al., Science 292, 2462 (2001)

[3] J.Haruyama, et al., Phys.Rev.B 68, 165420 (2003); Appl.Phys.Lett. 84, 4714 (2004); Microelectronics Journal 34, 537 (2003); Physica C 408, 85 (2004)