

Nano-Sized effects on the physical properties of la-based high-Tc superconductors and its parent compound ($\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ and La_2CuO_4) = Efek nano-sized terhadap sifat magnetik la-based high-Tc superkonduktor dan material induknya ($\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ dan La_2CuO_4)

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Abstrak

The change of the electric and magnetic properties due to the particle size effect has been reported recently and opened a new door to investigate phenomena driven by dimensional effects. One of the interesting examples is nanogold which is a weak diamagnetic in a bulk state but it becomes ferrimagnetic when the size of the Au cluster is around 3 nm. In the case of the Mott insulating system, it is reported that the magnetic transition temperature, T_N , drastically decreased due to nano-sized effects. The reason for the appearance of the ferrimagnetic phase and the reduction in T_N are not fully understood and still an open question. We investigated nano-sized effects in typical Mott insulator, La_2CuO_4 , and in high-Tc superconductor cuprates, $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$. From muon spin relaxation (SR) measurements, it is observed that the T_N drastically decreased to be 47(12) K with reducing the particle size of La_2CuO_4 down to 24 nm. The phase separation of long-range and short-range magnetic ordering state was observed. We proposed a core-shell model to describe it. Particle size affects the magnetic interaction in La_2CuO_4 where the inter-plane magnetic interaction, J' , plays an important role in controlling T_N of antiferromagnets. In the case of $\text{La}_{1.80}\text{Sr}_{0.20}\text{CuO}_4$, we found that there is a strong suppression of the superconducting state and the appearance of weak magnetism induced by nano-sized effects. These results revealed that magnetic orders and superconductivity are intertwined and interconnected in high-Tc cuprate superconductors.

.....Perubahan sifat listrik dan magnet yang disebabkan efek ukuran partikel telah diteliti secara intensif akhir-akhir ini dan membuka pandangan baru dalam investigasi fenomena yang di-drive oleh efek dimensi. Salah satu contoh efek partikel yang sangat menarik adalah nano-gold. Gold (Au) bersifat dimagnetik lemah dalam keadaan bulk tetapi menjadi ferrimagnetik saat ukuran cluster Au dikecilkan menjadi 3 nm. Di kasus sistem Mott insulating, suhu transisi magnetik, T_N , dilaporkan menurun karena nano-sized effects. Alasan munculnya fasa ferrimagnetik dan menurunnya T_N di sistem nano masih belum dipahami sepenuhnya dan masih menjadi pertanyaan. Kami menginvestigasi nano-sized effects di typical Mott insulator, La_2CuO_4 , dan high-Tc superconductor cuprates, $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$. Dari hasil pengukuran muon spin relaxation (SR), dihasilkan bahwa T_N menurun drastis menjadi 47(12) K dengan dikecilkannya ukuran partikel menjadi 24 nm. Dari hasil SR, teramati juga adanya pemisahan fasa antara long-range dan short-range magnetic ordering. Core-shell model diajukan untuk menjelaskan pemisahan fasa magnetic ordering yang terjadi di La_2CuO_4 nanopartikel. Kami menemukan bahwa inter-plane magnetic interaction, J' , berperan penting dalam mengontrol perubahan T_N di antiferromagnet. Pada kasus $\text{La}_{1.80}\text{Sr}_{0.20}\text{CuO}_4$, teramati adanya penurunan superconducting state secara drastis dan munculnya weak magnetism yang disebabkan oleh nano-sized effects. Hasil ini menunjukkan bahwa magnetic orders dan superkonduktivitas saling terkait dan berhubungan.