MAR10-2009-000318

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Pseudogap Mediated by Quantum-Size Effects in Pb Islands[1]

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Pseudogap is an important state of high temperature superconducting (HTS) materials. The origin of it, however, is still a debated issue in the HTS field. Bulk conventional superconductor is known not to have any pseudogap state. However, in our recent experiment, we discovered that nanostructured Pb island grown on Si(111)-(7x7) surface possesses a pseudogap. In many aspects, the behavior of this pseudogap is similar to what has been observed for HTS with scanning tunneling spectroscopy (STS). In this talk, I will present our results of the novel pseudogap, or in special cases a pseudopeak, around the Fermi level for Pb islands on Si(111) using STS measurements at high energy resolution. These gap or peak features persist to temperatures as high as ∼80 K and are uniquely related to the quantum well nanostructure of the Pb islands. Through a systematic analysis of the STS spectra of various Pb island thicknesses, we found that electron-phonon scattering and quantum confinement conspire to give rise to the pseudogap features in this system. This novel manifestation of quantum size effects has not been investigated before and may shine light in understanding the pseudogap state in HTS. Our findings also add a new dimension for the quantum confinement effects in metallic thin films/islands in addition to the quantum well states and thickness dependent superconductivity.

References: [1] Kedong Wang, Xieqiu Zhang, M. M. T. Loy, T.-C. Chiang, Xudong Xiao, "Pseudogap Mediated by Quantum-Size Effects in Lead Islands", Phys. Rev. Lett. 102, 076801 (2009).

[1]This work was supported by the Research Grants Council of Hong Kong