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Optical Investigations on Spin Density Wave Instability and Pseudogap Formation in $EuFe_2As_2$

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Recently, the discovery of high-temperature superconductivity in iron-pnictides has excited great interests in investigating their physical properties. Like cuprates, the superconducting state of iron-pnictides is located beside the magnetically ordered state. The parent iron-pnictide compounds exhibit stripe-type antiferromagnetic spin density wave order. The carrier doping or the application of pressure to the parent compounds suppress the antiferromagnetic order and gives rise to the superconductivity. The close proximity of the superconductivity and the antiferromagnetic order suggests that the antiferromagnetic interaction might be a crucial ingredient for the superconductivity. Therefore, it is imperative to study the electronic structure changes of the parent compound across the spin density wave transition.

We investigated the electronic structure of $EuFe_2As_2$, which exhibited spin density wave transition at about 190 K. As temperature decreases across the spin density wave transition, the Drude-like response in optical conductivity spectra $\sigma(\omega)$ becomes suppressed and developed into the gap-like structure and sharp Drude response, indicating the partial gap opening at the Fermi surfaces. Interestingly, two-gap structure was observed in $\sigma(\omega)$ at the spin density wave phase. We found that one of the gaps evolves essentially in a mean-field manner and the other gap involves wholesale changes of the band structure. The possible origin of the unusual two-gap structure will be discussed.

Keywords : optical conductivity spectra, $EuFe_2As_2$, spin density wave,