Time Resolved Fluorescence Study of Photoinduced Defect States in $YBa_2Cu_3O_{6+\delta}$

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We have observed long lived flourescence doublet in semiconductig $YBa_2Cu_3O_{6+\delta}$ with a lifetime of approximately 4 ms at room temperature increasing to 6 ms at 10 K. At low temperatures we have also observed a time dependent energy shift with a lifetime very similar to the flourescence lifetime.

Samples we used in our experiments were high quality well characterized single crystals and many ceramic samples of different origin. We have found the flourescence only in samples with oxygen concentration between approx 6.1 and 6.3. The samples were photoexcited by short laser pulses. We used different lasers to perform photoexcitation: 1) Q-switched frequency doubled Nd:YAG (532 nm), 2) mechanically chopped argon (514.5 nm) and 3) mechanically chopped HeNe (633 nm). The excitation pulse length varied between 200 ns for Q-switched Nd:YAG and up to 1 ms for chopped lasers. Open/close duty cycle was more than 1:1000 when using Q-switched Nd:YAG laser and at least 1:16 for chopped lasers. The flourescence light was dispersed on a triple monochromator amplified with a microchannel plate intensifier and recorded with a diode array detector. Time resolved measurements were done by gating the microchanel plate intensifier.

To make sure that extremely weak fluorescence was not an experimental artifact we made several precautions: 1) Samples were kept in a dry nitrogen atmosphere. 2) We examined the precursor substances as well as decomposition products (Y_2O_3, $BaCO_3$ and CuO), samples which were reduced in Ar atmosphere beyond $YBa_2Cu_3O_6$, multiphase ceramic samples and those which were kept in open air for long periods. We could not find any delayed emission near observed fluorescence. 3) To exclude the posible effects of lubricant and abrasive used for polishing we polished the ceramic samples dry i.e. on a pad without lubricant and abrasive. The single crystal samples were not polished. We did not find any conection between polishing and observed fluorescence. 4) The samples were mounted with and without glue. That produced no effect on the signal too. Although the above mentioned precautions do not

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exclude the posible effects due to molecules adsorbed on the surface the very consistent signal intensity indicates this not to be the origin of the fluorescence.

At low temperatures we have observed the time dependent frequency shift (fig1.) which has been to big to be contributed to thermal effects. In addition its time dependence has been equal within the precision of the measurement to the lifetime of the fluorescence. This suggests that collective effects may be involved.

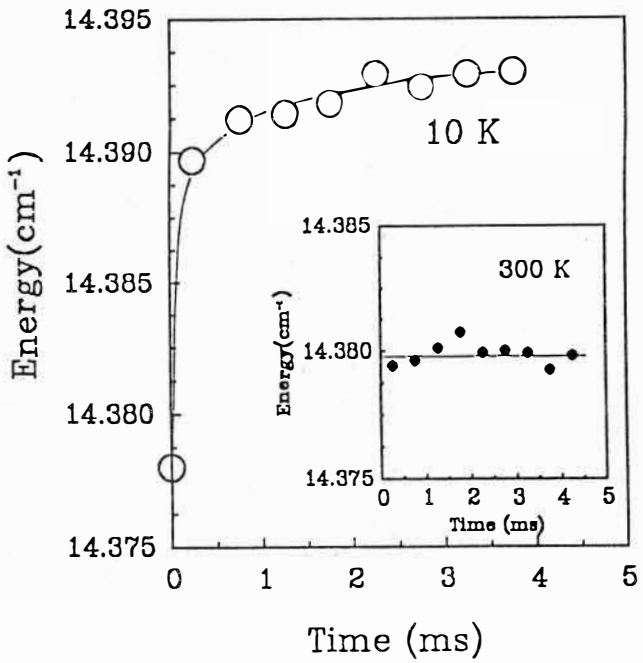

Figure 1. Energy shift of the exciton fluorescence as a function of time at 10K No frequency shift can be observed on the same timescale at room temperature (insert).