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# Some peculiar features of the newest layered high-$T_c$ superconductors

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Some features of the high-$T_c$ superconductors are analysed. They are the following: dependence of transition temperature $T_c$ on the number of layers; peculiarities of the optical reflection spectrum of the layered high-$T_c$ superconductors.

## 1. INTERLAYER EFFECT IN THE NEWEST HIGH-$T_c$ SUPERCONDUCTORS

New bismuth and thallium high-$T_c$ superconductors contain several N (1,2,3,4,5,6) $CuO_2$ planes forming sheafs between individual layers of thallium oxides. The first theoretical investigation of the dependence of $T_c$ on the number of $CuO_2$ layers within a sheaf was carried out by Anderson [1]. In all his work it was shown that the value of $T_c$ increases monotonically with the number of layers in sheafs and attains a constant value for $N \geq 10$. However, experiments carried out in 1989 by Kikuchi et al. [2] revealed that it is not true. The authors of paper [2] synthesized the superconductor $Tl_1Ba_2CaCu_4O_{12}$ and observed a decrease in the value of $T_c$ upon a transition from three or four layers. They also synthesized a series of superconductors $Tl_1Ba_2CaN_{-1}Cu_NO_{2N+3}$ with the number $N$ varying from two to five and proved that the value of $T_c$ increases with $N$ to $N = 4$ and decreases for $N = 5$. It was noted in Ref. [3] that such a decrease is also observed for $N = 6$.

Experimentally observed decrease in $T_c$ for large values of N was explained by following. In papers [4,5] the calculation of critical temperature $T_c$ of a layered superconductor of sheafs of $CuO_2$ planes for a fixed separation between planes was made. In this case it was shown that the value of $T_c$ increases monotonically with the number of layers. If we calculate the critical temperature $T_c$ of layered superconductors of sheafs of $CuO_2$ planes with a varying separation between the planes, we have the decrease in $T_c$ for large values of N.

It is shown that the observed nonmonotonic dependence with the maximum at some layers can be explained only if one takes into account the changing of interplanar distances, arising with the generation of bisoliton [4].

Fig.1 shows the $T_c$ dependence on the number N of plane layers in unit cells ($Tl_1Ba_2Ca_{N-1}Cu_NO_{2N+3}$). Experimental data are marked by circles.

This research obtains actual with the creation of the compoun $(Ca_{1-x}S_{2x})_{1-y}CuO_2$ with an "infinite" number of $CuO_2$ layers.

## 2. INTERLAYER HYBRIDIZATION AND OPTICAL REFLECTION SPECTRA

The purpose of this report is to study theoretically certain potical peculiarities inherent to these crystals proceeding from their structural properties ($T > T_c$). The most complete data on optical properties of these substances are given in [7]. The fact that peculiarity of E $\sim$ 4 ev in $Bi_2Sr_2CaCu_2O_{8+x}$ abd $Bi_2SrBCuO_2$ crystals consists of several peaks and forms relatively intensive and wider reflection band than in $(Ca,Sr)CuO_2$ implies that excitations in $CuO_2$ layer same as in $Bi_2O_2/SrO$ layers give, probably, the total contribution to this wide reflection peak. Generally speaking, the $Bi_2O_2/SrO$ layers can also be isolating and have no direct relation to superconductivity.

We investigate spectral characteristics of absorption and reflection coefficients $n(\omega)$ and $R(\omega)$, respectively. It is shown that the hybridization of states of bismuth ($Bi_2O_2$) and cuprate ($CuO_2$) layers results in anomalously wide and

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stuctural lines in the reflection spectra. The comparison with the calculation of the spectrum for the basic reflection maximum is made and the parameters of the intraplanar interaction are defined.

Fig.2 shows the results of theoretical dependence of reflection spectra $R(\varepsilon)$ on the energy $\varepsilon$. Experimental data are shown by solid line and theoretical data by dashed line.

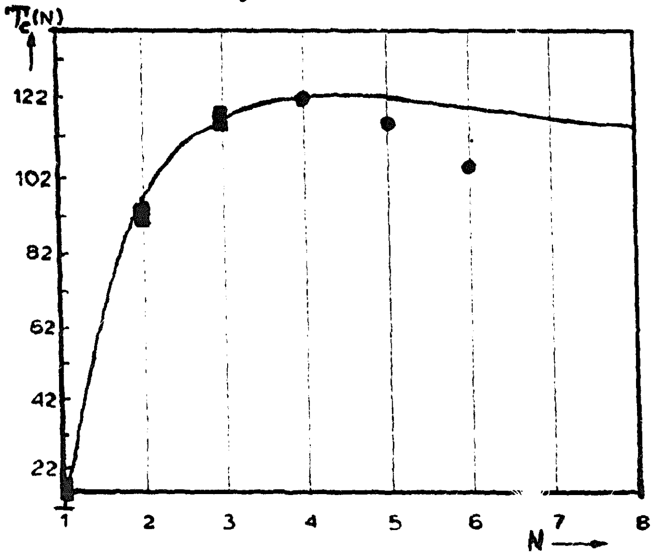


Figure 1. The theoretical dependence of $T_c$ on the number N of plane layers. Experimental data are marked by circles.

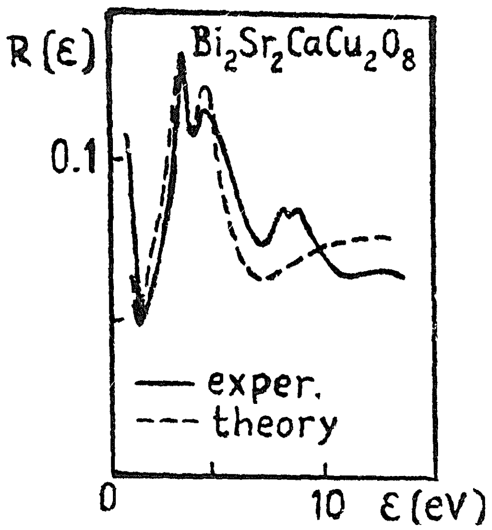


Figure 2. The dependence of reflection spectra $R(\varepsilon)$ on the energy $\varepsilon$.

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