Since Bednorz and Müller /1/ discovered high-\( T_c \) superconductivity in the La-Ba-Cu-O compound, several families of superconducting oxides have been synthesized /2/. In this paper we report the results of search for superconductivity in the compounds based on tin which has a lone electron pair like Bi, Tl, Pb.

The following compounds were synthesized: \( \text{Sn}_x\text{Ba}_y\text{Sr}_z\text{Cu}_3\text{O}_x \), \( \text{Sn}_x\text{Ba}_y\text{Ca}_z\text{Cu}_3\text{O}_x \), \( \text{Sn}_x\text{Ba}_y\text{Mg}_z\text{Cu}_3\text{O}_x \), \( \text{Sn}_x\text{Sr}_y\text{Ca}_z\text{Cu}_3\text{O}_x \), \( \text{Sn}_x\text{Sr}_y\text{Mg}_z\text{Cu}_3\text{O}_x \), \( \text{Sn}_x\text{Ca}_y\text{Mg}_z\text{Cu}_3\text{O}_x \). The initial components were oxides and carbonates of the appropriate elements. Standard firing-grinding procedure was used. Final heating was carried out at 960°C during 12 hours. Then the samples were cooled inside the furnace. All the synthesis cycles were carried out in air atmosphere.

Among the synthesized compounds only \( \text{Sn}_x\text{Ba}_y\text{Sr}_z\text{Cu}_3\text{O}_x \) showed remarkable conductivity (\( \rho \sim 10 \) \( \text{Ohm} \cdot \text{cm} \)). Other compounds were practically dielectrics (\( \rho > 1000 \) \( \text{Ohm} \cdot \text{cm} \)). Presence of a possible superconductivity in \( \text{Sn}_x\text{Ba}_y\text{Sr}_z\text{Cu}_3\text{O}_x \) was defined by using the Meissner effect. At low temperature a deviation from paramagnetic behaviour is observed. The hysteresis loops obtained at lower temperatures undoubtedy testify to the presence of a superconductive phase in the sample. However, the part of the superconductive phase in the \( \text{Sn}_x\text{Ba}_y\text{Sr}_z\text{Cu}_3\text{O}_x \) ceramic turned out to be small, less than 2%, which agrees with the estimation from magnetic data. In order to increase the content of the superconductive phase two-valent cations Ba, Sr were partially substituted by univalent (K) and three-valent ones (Y). Two samples were obtained: \( \text{Sn}_x\text{Ba}_y\text{Sr}_z\text{K}_t\text{Cu}_3\text{O}_x \) and \( \text{Sn}_x\text{Ba}_y\text{Sr}_z\text{Y}_t\text{Cu}_3\text{O}_x \). The former is a typical paramagnet without any anomaly down to 4.2K. The latter has shown the magnetic and electric properties undoubtedy indicating the presence of a superconductive phase with the onset temperature \( T_c \approx 55K \). The superconductive properties of the sample do not seem to be caused by the phase \( \text{YBa}_2\text{SrCu}_3\text{O}_7 \) /3/. This conclusion follows from the study of the \( \text{Sn}_2\text{Sr}_2\text{Ba}_0.5\text{Y}_{0.5}\text{Cu}_3\text{O}_x \) and \( \text{Sn}_2\text{Ba}_2\text{Sr}_{0.5}\text{Y}_{0.5}\text{Cu}_3\text{O}_x \) samples that were synthesized by analogy with the recent communications on superconductivity in \( \text{Pb}_2\text{Sr}_{2}\text{Ba}_{0.5}\text{Y}_{0.5}\text{Cu}_3\text{O}_x \) /4, 5/. One may expect equal probability of the \( \text{YBa}_2\text{SrCu}_3\text{O}_7 \) content for both samples, however their electrical properties are quite different. The compound \( \text{Sn}_2\text{Sr}_2\text{Ba}_{0.5}\text{Y}_{0.5}\text{Cu}_3\text{O}_x \) is a good dielectric while \( \text{Sn}_2\text{Ba}_2\text{Sr}_{0.5}\text{Y}_{0.5}\text{Cu}_3\text{O}_x \) has clearly expressed superconductive properties 76/. The magnetic moment was measured in an external field \( H = 100 \) \( \text{Oe} \). At \( T < 86K \) the sample exhibits a clearly defined diamagnetic behaviour characteristic of superconductors. At these temperatures the hysteresis loop has the form typical of high-\( T_c \) superconductors. The amount of the superconductive phase in this sample, as a magnetic estimation in powder, is \( \sim 15\% \) of the volume of the sample.
A comparative analysis of the X-ray powder diagrams leads us to believe that the main motive of the $Y_1Ba_2Cu_3O_7$ structure is preserved in the structure of $Sn_2Ba_2SrO_{1-5}Y_0.5Cu_3O_x$. The unit cell parameters are: $a = 4.1 \, \text{Å}$, $c = 12.4 \, \text{Å}$ (or multiple).

We have also used the same procedure for $Sn_1Ba_2SrO_{1-5}Y_0.5Cu_3O_x$. The sample is a typical paramagnet without any anomaly down to 4.2 K.

The presence of superconductivity in the system based on tin allows us to suggest that other cations, besides the well-known Bi, Tl, Pb, having the lone electron pair effect, should also form superconductive compounds. If we limit ourselves to consideration of copper-containing oxides, we may suppose that definite alkali-earth ions (or their combination) would suit for each of the ions: Hg, Sb, In, ... in order to form a superconductive phase.

References