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Formation of Stable Y-Ba-Cu-O Films on Si Substrates via Intermediate Al Layer

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Formation of high-temperature superconductor films on Si is of great interest for a variety of applications ranging from interconnects in IC's to hybrid semiconductor/superconductor devices. One of the major problems in the formation of the superconductor films on Si substrates is the fact that the adhesion of the films to the substrate is very poor. This poor adhesion may be related to some undesirable chemistry at the film/substrate interface.[1)] In order to suppress the interfacial reaction, several buffer layers such as Ag[2)], Y_2O_3[3)], and ZrO[4)] have been investigated. Among them, ZrO has been demonstrated to be effective in forming Y-Ba-Cu-O films having T_c higher than 77K. We report here the successful fabrication of stable Y-Ba-Cu-O films on SiO_2/Si substrates by using Al as an intermediate layer.

Figure 1 shows a schematic cross-section of samples prepared. Si wafers which have native SiO_2 at the surface were half coated with 50-200nm thick Al by vacuum evaporation. Then a ~30um thick Y-Ba-Cu-O film was deposited on the whole surface of the wafer by plasma spray method. The spray coating was carried out in open air by using a spray gun(METCO 7MB). The wafer was heated to 300°C prior to the deposition. The samples were then annealed in dry O_2 ambient at 950°C for 5 hrs. The cooling rate was 2°C/min to 700°C followed by 1°C/min to room temperature.

Figure 2 demonstrates the successful stabilization of Y-Ba-Cu-O films by using the Al layer. In the region without the Al layer, the film peels off in some areas and cracks are observed over the whole surface. On the contrary, in the region with the Al layer, neither peeling nor cracking appears. In Figure 3, typical resistance-temperature characteristic is shown for a film formed on an Al coated substrate. We can see that T_c of about 87K is obtained by using this technique. Figures 4(a) and 4(b) show cross-sectional SEM images for samples prepared without and with Al, respectively. In the sample without Al, a layer (marked A) and pockets(marked B) are observed at the interface. The pockets appear to be responsible for the liftoff of the film from the substrate. XMA analyses have revealed that the interfacial layer is a Ba-Si compound and the pockets are precipitated Cu. These agree with the previous RBS analyses made on the same system.[1)] On the other hand, in the region with the Al layer, the Cu precipitate is absent while a similar Ba-Si interfacial layer is also present. Thus the Al intermediate layer prevents precipitation of Cu, thereby improving film adhesion.

In conclusion, the Al predeposition is shown to be effective for formation of crack-free adhesive Y-Ba-Cu-O films on SiO_2/Si. This simple technique has important potential applications, especially in interconnect technology.

(References)

1) P. Madakson, J. J. Cuomo, D. S. Yee, R. A. Roy, and G. Scilla: J. Appl. Phys. 63(1988)2064.
2) M. Gurvitch and A. T. Fiory: Appl. Phys. Lett. 51(1987)1027.
3) A. Mogro-Campero, B. D. Hunt, L. G. Turner, M. C. Burrel, and W. E. Balz: Appl. Phys. Lett. 52(1988)584.
4) A. Mogro-Campero, L. G. Turner, E.L. Hall, and M.C. Burrell: Appl. Phys. Lett. 52(1988)1185

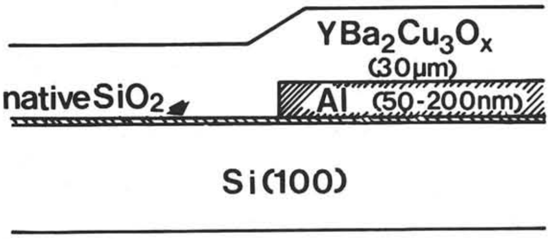

Fig. 1. Schematic illustration of samples prepared.

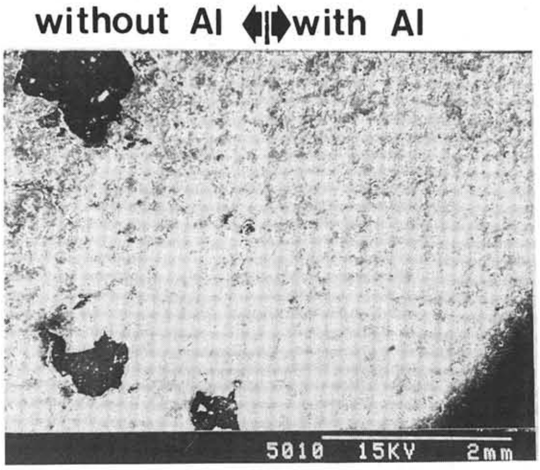

Fig. 2. SEM image of the surface of the Y-Ba-Cu-O film formed on the 200nm thick Al half-coated (right side) Si wafer. This micrograph was taken after exposing the sample to the ambient for 7 days after annealing.

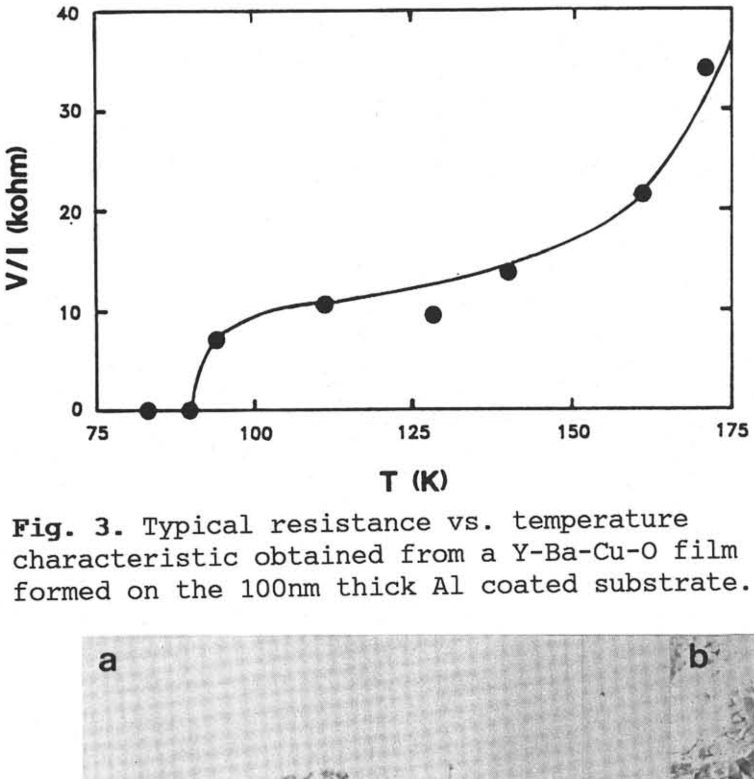

Fig. 3. Typical resistance vs. temperature characteristic obtained from a Y-Ba-Cu-O film formed on the 100nm thick Al coated substrate.

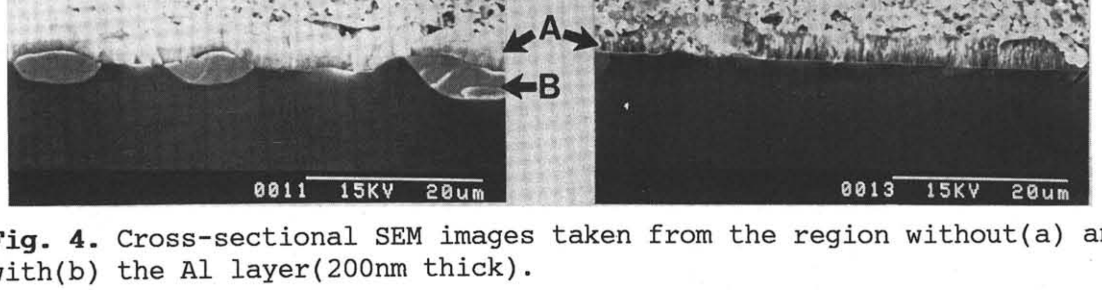

Fig. 4. Cross-sectional SEM images taken from the region without(a) and with(b) the Al layer(200nm thick).