On the Electrical properties of the C/Au thin film electrode deposited Over LTCC substrate

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In last few years the increase in the level of functions required of wireless communications has necessitated the use of higher frequency ranges. As a result of this progress a very rapid growth of applications of Low Temperature Co-fired Ceramics in wireless communications has been observed recently. The Low Temperature Co-fired Ceramic (LTCC) Technology has been extensively explored in the microelectronics industry as a ceramic packaging technology for integrated microcircuits [1-2]. Additionally, LTCC was applied for the production of sensors and actuators due to its very good electrical and mechanical properties, high reliability and stability as well as possibility of making three dimensional (3D) integrated microstructures. A typical LTCC module consists of dielectric tapes, connecting vias, external and internal conductors and passive components [3].
Thin-film science and technology also play a crucial role in the high-tech industries and the major exploitation of thin films has been in microelectronics. Microelectronic packages for high frequency application require conductive materials with high conductivity. Lower temperature firing of ceramic blocks of about 850°C allows utilization of highly conductive and low resistive metals such as gold. Gold produces a very high definition and reliable circuit [4]. However, some restrictions limited these advantages like high diffusion coefficient [5] and poor adhesion of the Au metallic films on the substrates which hamper specific applications extensively.

Many transmission lines and electrodes used in microelectronics have conductors deposited directly on a substrate. Therefore, two Au thin films with different thicknesses 50 and 100 nm were deposited with DC sputtering technique over the LTCC substrate. Then by considering aforementioned problems of using metallic thin films as electrodes, a 100 nm C thin film layer has been deposited on Au/LTCC layer with Au 50 nm in order to avoid Au adhesive problem. Finally samples were annealed in Ar ambient for 1, 5, 10, 15 and 20 min. Thermal treatment has been done in order to make solid state reaction for mixing the layers to increase adhesive characteristics and observe possible modification of the conductive properties. We explored the obtained results of electrical property to improve functionality of the circuits in terms of the Au conductors.

Surprisingly, it was found that C/Au/LTCC bilayer annealed for 1 min shows more desirable conductance behavior in compare with as deposited sample and those annealed for higher annealing times. It can be due to improving interfacial contact between 2 layers by diffusing some atoms through the interface and avoiding sharp interface effect which may scatter electrons when are passing along. In addition, it was expected that sample with carbon layer have less conductance in compare with Au/LTCC samples (due to the low conductivity of C), but interestingly it could be observed that the conductance of the C/Au/LTCC bilayer with 1 min annealing time is comparable with the Au/LTCC which the thickness of gold is 100 nm. Therefore, in this study we could improve adhesion of Au thin film electrodes over LTCC substrates without losing electrical property and. strong film stability has been seen with applying C layer over Au/LTCC. Thereafter, the conductance of annealed bilayers at 500°C for 1 min reached to the maximum which may be owing to improved contact between the layers which could be a solution to overcome low conductance of the deposited bilayers.

References:

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Figures:

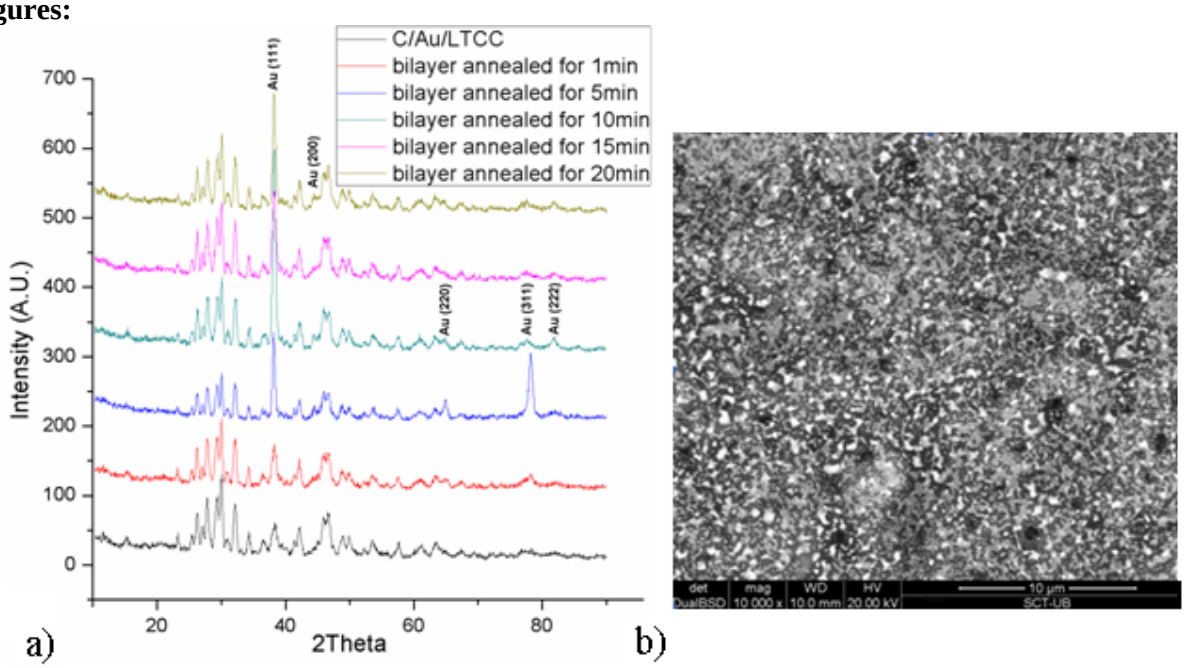

Fig 1. *a) XRD results of C/Au/LTCC in which being textured along (111) crystal direction is noticeable. b) SEM image of C/Au/LTCC bilayer annealed for 10 min at 500°C.*

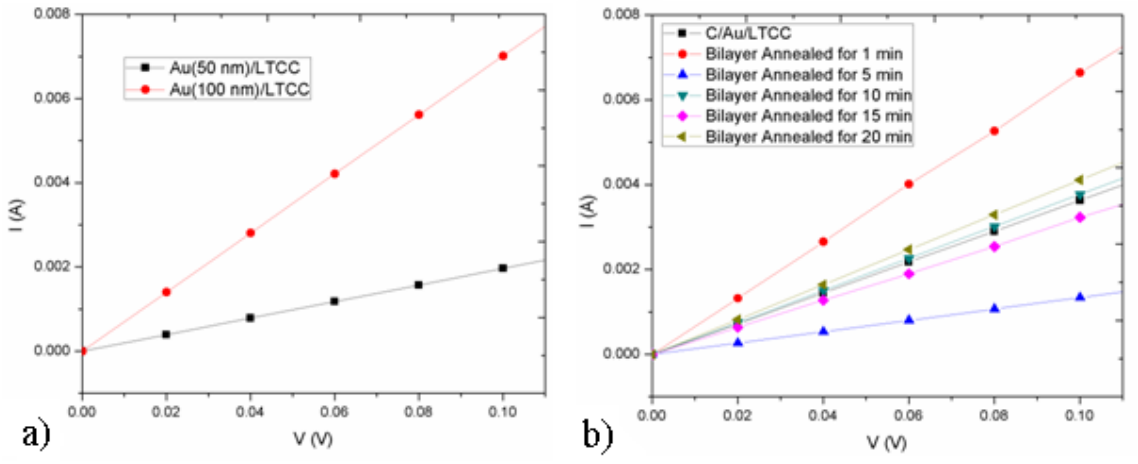

Fig 2*. a) I- V plot of Au/LTCC with 50 nm and 100 nm thicknesses. b) I- V plot of C/Au/LTCC as deposited and annealed at 500°C for 1, 5, 10, 15, 20 min. Maximum conductance of the C/Au bilayer has been seen after 1 min annealing.*