Chapter 5

ADHESION MECHANISM OF THICK FILM CONDUCTORS

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1 INTRODUCTION

Thick film conductors consist of a metallic phase which, after firing, adheres to 96% alumina substrates. The method of adhesion depends upon deliberate minority constituents added to the conductor ink which forms the bonding layer between the metal and ceramic. The nature of this bonding layer and the adhesion mechanisms involved are critical in determining the necessary processing conditions. The substrate type, its composition and structure, may also determine the effectiveness of the bonding layer.

Many of the conductor inks and substrate materials described were developed over a decade ago and some are no longer available or have been superseded by improved compositions.

2 FRITTED CONDUCTORS

2.1 The Effect of Firing Temperature

Thick film inks are dried at a temperature of typically 150°C for 20 minutes to drive off the organic solvents after printing. The ink pattern as defined by the printing process is maintained by an organic binder which holds the structure together. The patterned substrates are then fired through a conveyor belt furnace, experiencing a temperature profile. The firing time is typically 30 to 45 minutes with a rate of rise of between 50°C and 100°C per minute to a plateau at temperatures between 750°C and 1000°C, fig. 1.

A silver-palladium conductor, C4020, produced by Alloys Unlimited, printed on a Stemag substrate, was fired under various profiles giving peak temperatures between 600°C and 900°C. On each substrate there were five
Fig. 1 Typical conductor firing profile with a peak temperature of 850°C

Fig. 2. Diagram of pull-peel adhesion test