EMI SHIELDING FOR SYSTEM IN PACKAGE USING NOZZLE-LESS ULTRASONIC SPRAY COATING AND SILVER PARTICLE FREE INK

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ABSTRACT
There is a constant drive to pack electronics into smaller spaces. Recently, smart watches have been major drivers of further miniaturization and spurred System in Package "SIP" innovations. SIP enables several integrated circuits (ICs) along with larger capacitors/inductors to be housed in one package. Many of these ICs operate at radio frequencies and the proximity increases electromagnetic interference (EMI). The traditional solution of soldering a "metal can" is not feasible. Compartmental shielding of the package is necessary and sputtered metal has typically been utilized to provide the shield.

The traditional sputtering method is a Physical Vapor Deposition process (PVD) that involves vaporizing a metal and depositing it onto the surfaces of the components. PVD is currently the most commonly used method to apply the EMI shield and it requires a complex, multi-step process. New materials and application methods are required to increase performance and reduce costs associated with producing an effective EMI shield. The EMI shield layer must be applied in a uniform layer on the package surfaces and into the trenches between compartments.

This paper demonstrates the capability of a revolutionary particle-free silver ink in conjunction with a novel coating application technology in the form of a nozzle-less ultrasonic spray technology and digital dispensing technology. Performance parameters including coating thickness uniformity, EMI shielding effectiveness, adhesion, process cost will be compared and analyzed between this approach and other silver inks and application methods. Results of these analyses will be presented along with performance improvement and cost reduction potential of this technique for high-volume manufacturing.

Key words: Advanced Packaging, EMI, silver precursor, nozzle-less spray, ultrasonic spray coating, component level shielding

BACKGROUND
There is a constant drive to pack electronics into smaller spaces. Recently, smart watches have been major drivers of further miniaturization and spurred System in Package "SIP" innovations. SIP enables several integrated circuits (ICs) along with larger capacitors/inductors to be housed in one package. Many of these ICs operate at radio frequencies and the proximity increases electromagnetic interference (EMI). The traditional solution of soldering a "metal can" is not feasible. Compartmental shielding of the package is necessary and sputtered metal has typically been utilized to provide the shield. In this paper, an emerging cost-effective approach with certain technical advantages is presented which involves dispensing/spray coating silver ink to form a compartmental shield shown in Figure 1.

The traditional sputtering method is a Physical Vapor Deposition process (PVD) that involves vaporizing a metal and depositing it onto the surfaces of the components; see Figure 2. PVD is currently the most commonly used method to apply the EMI shield and it requires a complex, multi-step process. Once the components are placed and loaded, the process steps include: 1) degas; 2) plasma pre-treatment; 3) deposit an adhesion layer; 4) deposit the EMI shield layer and 5) deposit an anti-corrosion layer. This process is performed in a costly piece of equipment that occupies a large floor space. The space required is typically in the range of 12.5 to 35 m^2 and the capital cost is in the range of $3M to $8M USD. Sputtering has other technical limitations including, non-uniform coating of sidewalls and trenches, maintenance costs, material waste, and slow throughput.