Developing a Fundamental Understanding of Gold Spitting During Evaporation

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Abstract

We report on studies focused on the electron-beam (E-Beam) evaporation of gold (Au) that have enabled us to develop a fundamental understanding of the causes of spitting. Spitting during the evaporation of Au causes defects known as nodules or particles in the deposited film. These nodules can significantly affect production yields as they can lead to device malfunction through the breakdown of layered structures. There is thus a compelling need to reduce the number of defects caused by spitting during the evaporation of Au. In order to do, a thorough understanding of all the factors that contribute to spitting is required.

A Telemark 291 E-beam gun was used to deposit 2000 Å thick Au layers onto 100 mm diameter silicon (Si) wafers with the aid of a titanium (Ti) adhesion layers. Particles larger or equal to 0.5 µm that resulted from spitting were quantified with a KLA-Tencor 6420 wafer scanner. A gauge repeatability and reproducibility (Gauge R&R) study was conducted to quantify the amount of variance caused by the measuring system and the amount of variation was less than 10 % of the total variation.

We have found that the factors that affect spitting can be divided into two broad groups: 1) evaporation process parameters and 2) material quality. Process parameters that have an effect on the heat input or heat loss of the system have the most influence on spitting since they ultimately determine the temperature the liquid Au reaches during deposition. These parameters include deposition rate, power input, ramp profile, beam sweep pattern, the use or non-use of a crucible liner, crucible liner material, and the degree of contact between the crucible liner and the copper walls of the pocket. If these parameters are not carefully regulated, an out of control process results and causes significant variation in spitting and the resulting measured particles. One such effect, e-beam power input, is illustrated in Fig. 1. For a process that is in control, the quality of the Au plays a significant role in the degree of spitting. The level of purity, cleanliness, and the Au manufacturing methods were all shown to influence the amount of spitting.

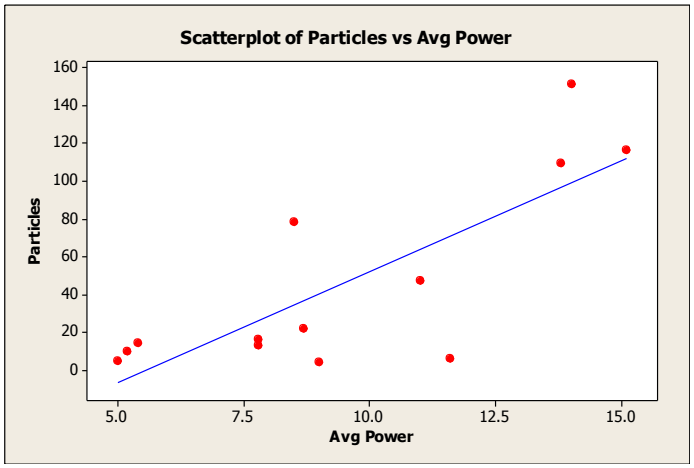

Fig. 1 The effect of average power during deposition on particles generated from spitting