First insertion failure of Dual In-line Memory Modules (DIMMs) is a detrimental, industry-wide issue. Potential causes of failure were investigated by analyzing DIMM pins and server sockets with Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS), and Optical Microscopy. DIMMs were inserted into servers to test for failures. After testing, contamination was determined to be the most likely failure cause.

**Project Description**

During server assembly, DIMMs are inserted into server sockets. Upon initial insertion, the servers fail at a problematic rate. This is called first insertion failure. When a failure occurs, failed DIMMs must be reinserted and the server must be rebooted. This reduces production rate and causes financial loss across the entire industry. This project investigated the root cause of failure.

**Causes of First Insertion Failure**

- Poor electrical contact between DIMM and socket
- Failure by inhibited contact due to contamination
- Failure due to large variation in surface morphology

The initial hypothesis was that failure was primarily caused by surface roughness variation. After characterizing DIMMs and sockets, it was determined that surface contamination on DIMM pins is a more likely cause of failure.

**Sockets**

Sockets from two different suppliers (noted as 1 and 2) were investigated in terms of:

- Spring morphology
- Spring separation

Contact geometry was investigated by comparing cross section images. Supplier 1 uses a sharper angle; no other obvious differences observed. The contact area of Supplier 1 is 6% narrower than Supplier 2.

**DIMMs**

DIMMs from the two suppliers, A and B, were analyzed.

Differences noted in:

- pin shape
- surface features
- morphology

10 DIMMs were thoroughly analyzed, with the remaining 240 briefly scanned. Three abnormalities were discovered:

- Fibrous smudges
- Amorphous smudges
- Accumulation on the bottom of pins

Accumulation occurred on up to 40% of the pins of some DIMMs. Smudges appeared less frequently, only one or two on occasional DIMMs.

**SEM**

Optical Microscopy revealed changes to the board below the pins during insertion. SEM was used to further investigate their origin. The size and location of these board features indicate that the source is the socket springs.

**AFM**

- Roughness of DIMM pin surfaces analyzed with AFM to determine its influence on failure
- Used roughness parameter Ra
- Two areas were quantified: on and away from wipe marks, with 113 and 70 scans, respectively.

The roughness analysis indicated no significant difference in Ra on and away from wipe mark areas, indicating that the morphology of these areas is not a large influence on failure.

**Discussion**

**Sockets**

- With our small sample size of insertions, no correlation with socket supplier and failure can be concluded
- Surface roughness
  - Supplier B DIMMs were ~50% rougher than Supplier A, but do not have a significantly different failure rate
  - Failed DIMM roughness did not significantly vary from the overall average (away from wipe mark)

**Contamination**

Contamination is the most likely cause of failure. Two foreign materials were found on the two failures:

- Amorphous smudge (A/V1) - Failed on first insertion
- Fibrous smudge (A/V2) - Failed on third insertion

**Recommendations**

After concluding that contamination from smudges is the most probable cause of failure, we recommend investigating this further with a larger scale experiment. Cleaning the pins or sockets may improve insertion results and reduce failure rate.

**Acknowledgements**

We would like to thank Dr. Peng Su & Thuy Nguyen for their insight and collaboration. We would also like to thank our advisors, Professors Blendell & Handwerker, for their knowledge and guidance.