University of Arkansas Microelectronics-Photonics Graduate Program

PhD Candidacy Exam – March 2006

Advanced Materials, Processing, And Devices at the Micro to Nano Scale as Applied To Electronics

PROBLEM TO BE SOLVED

You are the chief engineer for GuanCo, a company that manufactures packaged memory chips for laptop PC's. GuanCo makes both the IC's and the packages, so therefore has total control over the design, manufacturing, and sales flow of the product. Currently, GuanCo's product line is a 72 pin SODIMM using eight chips, four on each side.

It has been proposed by your CEO to begin manufacturing memory IC's with circuitry on both sides of the chip, effectively doubling the memory density per module without decreasing memory cell and on-chip interconnect feature size. The notion is that most or all of the company's present chip-making tools could still be used. (May or may not be true.) This new unit should fit into existing slots used by the current product line.

Another group at GuanCo is looking at the possibility of manufacturing the IC's on just one side of a wafer, thinning the wafer, dicing out the chips, and gluing them back-to-back. Your task is to look at fabricating IC's on both sides of the wafer to avoid the thinning and gluing steps.

The main issue is to determine if this can be done in a cost-effective manner compared to the current practice, taking into account the resulting doubling of memory capacity, and without degrading the performance.

NOTE: You can assume that an internal team has already demonstrated a proprietary technology to allow for defect-free clamping of silicon wafers having active circuitry to processing equipment. It is not your job to worry about this issue.

YOUR DELIVERABLE

Your task is to write an internal proposal for your corporate officers describing your approach to this issue. Be sure you address at least all of the following:

Current Technologies - What is already being done in this area by other researchers, companies and governmental institutions? The current state-of-the-art for both the science and the implementation should be described, making use of diverse resources such as science literature, journals, conference proceedings, the internet, patents or other sources of existing public knowledge. Be sure to cite all references used.

Your design for IC Manufacture - How does a two-sided memory IC project contribute to maximizing utilization of existing front-end equipment? How will the two sides of the IC communicate with one another? How will the IC be connected to communicate with the higher level system? Be sure to address both the scientific and engineering issues of the question, carefully explaining performance considerations and any cost-performance tradeoffs.

Your design for Packaging - How can these chips be packaged into a configuration that fits the existing 72 pin SODIMM slots? How will the chip-to-package connections be made? What concerns arise with thermal dissipation and how does you design address these concerns? What customization of the standard 72 pin SODIMM is required, and how do you justify deviating from the standard?

Other Issues – Address any other issues of major importance

Manufacturing Flow - Detail the step-by-step procedure for making these structures in a form useful in manufacturing.

Testing and Qualification - Describe a set of tests and demonstrations that you will use to demonstrate the effectiveness of your approach. GuanCo cannot afford to lose market share, and needs to ensure that the all new product launches go smoothly.

Cost Analysis - Perform a cost analysis that includes, at least, acquisition of raw materials, labor rates, costs per operation, etc. You may exclude from your analysis possible additional costs in such infrastructure areas as human resources, facilities engineering, janitorial and grounds, upper level management, etc. You must include all direct manufacturing costs, both startup and continuing; and you must discuss explicitly space and personnel requirements to set up a stand-alone product line. Generic "per process" costs for various manufacturing methods can be used, as long as they are rationally applied. You should make comparisons to GuanCo's current products having single-side processing, as well as to memory modules obtained from other suppliers.

Intellectual Property - List in rank order of importance all IP sources that were consulted while formulating the answer, including the full list of examined documents along with key important reference data as an appendix to this exam. For instance, if the IP source is a patent, include the patent number; title; inventor name; and assignee name. (The full list will not be counted as part of the 15-page limit.) The three that are the most significant threats to your solution should be discussed within the 15-page document, making comparisons of strengths and weaknesses of these approaches relative to your own.