

January 2010

## Semiconductor Industry Opinions Concerning the Selection of Bonding Wire Material

### EXECUTIVE SUMMARY

SEMI® conducted a survey on behalf of the World Gold Council to gain insight into current attitudes regarding the use of gold bonding wire versus copper bonding wire. Forty-six leading semiconductor companies, including both integrated device manufacturers (IDM) and fabless companies, responded to the survey.

- The 46 companies responding to the survey were from across the world and had 2008 revenues totalling \$137 billion. This is representative of 55% of the global semiconductor industry in terms of revenues, and the survey includes responses from fourteen of the top twenty ranked suppliers for 2008.
- The results show that 59% of the companies surveyed currently do not use copper wire technology in any of their products, 41% use it in some products, and none of the companies use it in the majority of products.
- The majority of the companies surveyed, 72%, are considering the switch to copper wire for some new products, 13% are considering it for the majority of products, and 15% are not considering switching.
- All respondents except one identified important advantages of gold bonding wire over copper bonding wire. Twelve companies selected "Total Cost" as their only response in identifying advantages of gold wire over copper wire.
- The main concerns that would prevent the companies using copper wire technology in the future (in order) is in-service reliability, closely followed by process yield, and unproven historical performance.
- Eighteen companies surveyed were unaware that over 50% of the economic value of some end-of-life electronic products is derived from the gold content and only 21% of companies consider the impact on recyclability of waste electronics when selecting bonding wire material.

### Background

SEMI has conducted a survey, on behalf of the World Gold Council (WGC) to gain insight into current attitudes in the semiconductor industry regarding the use of gold bonding wire versus copper bonding wire for semiconductor packaging. Consumption of copper wire has been growing in the industry as the price of gold has increased in recent years. According to the recently completed *Global Semiconductor Packaging Materials Outlook* report issued by SEMI and TechSearch International, 2009 copper wire shipments from the major wire suppliers to the semiconductor industry will reach approximately 5.8% of total shipments (in meters), up from just 1.6% of the shipments reported in 2007.

The SEMI Industry Research and Statistics group provides market data and research reports covering semiconductor capital equipment, semiconductor materials, packaging materials, and fabs. We collect actual data from suppliers around the world following strict professional standards of confidentiality. Our reports help the industry make important investment, strategic and planning decisions by providing timely and accurate market research and market forecasting programs. For more information visit [www.semi.org/marketinfo](http://www.semi.org/marketinfo)

## Methodology

The surveys were conducted from October 13, 2009 through December 15, 2009. Surveyed companies include both integrated device manufacturers, companies with internal semiconductor device (chip) production, and fab-less semiconductor companies, companies that design their own chips but outsource the manufacturing of both the die and package. Wafer foundries and packaging subcontractors were not included in the survey as final design decisions rest with the IDM and fabless companies. While many IDMs package their own chips, some utilize packaging subcontractors for the final packaging, assembly, and testing of their chips. These “back-end” manufacturing partners offer gold and, increasingly, copper bonding wire capacity.

Twenty-eight IDMs and 18 fabless companies responded to the survey. Combined revenues of the 46 responding companies totalled \$137 billion in 2008, or 55% of the total worldwide, \$248.6 billion, reported by *World Semiconductor Trade Statistics Bluebook*. The 46 companies responding to the survey were from across the world. The survey includes responses from fourteen of the top twenty ranked suppliers for 2008.

This report documents survey results to six questions covering trends and issues related to both current and future bonding wire needs. (Some companies did not reply to every question).

## Survey Results

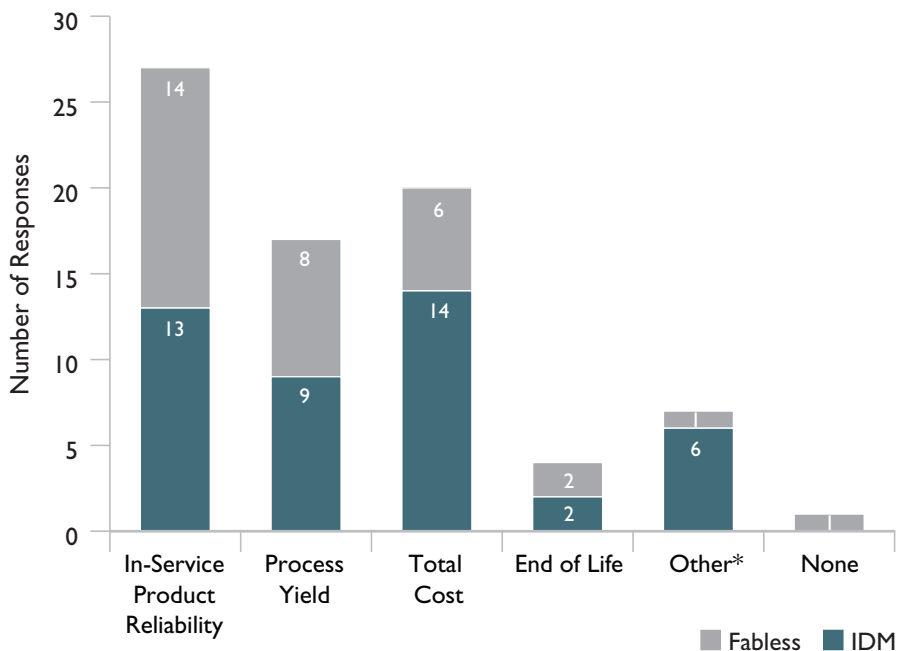
### Question I

#### I. What do you consider to be important advantages of gold bonding wire over copper bonding wire in packaging applications? (Select all that apply)

All respondents, except one, identified advantages of gold bonding wire over copper bonding wire. Twelve companies selected “Total Cost” as their only response to Question I.

\* Other

- High temperature/high reliability/industry follower
- Not suitable (copper) for the formation of complex wire loop shapes in advance packages
- (Company is) targeting flip chip
- Established industry-wide acceptance
- Equipment productivity
- Customer acceptance

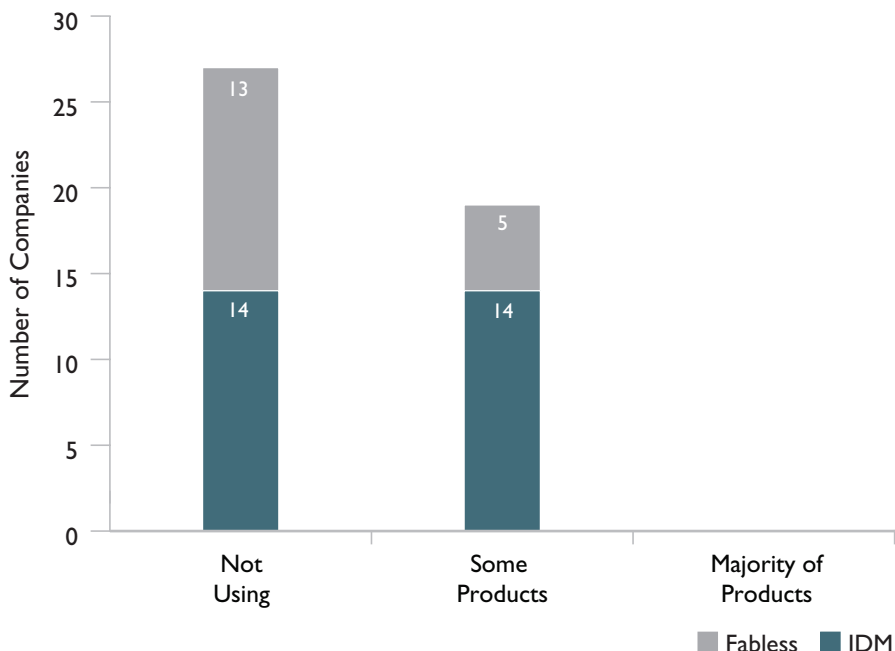


### Question 2

#### 2. To what degree do you currently use copper bonding wire technology in your products/packages?

59% of companies are not currently using copper bonding wire technology in their products/packages.

Of the 46 companies responding to the question, a total of 27 companies currently are not using copper wire in products, including 14 IDM and 13 fabless. Nineteen companies are currently using copper wire in some products and this includes 14 IDM and 5 fabless companies. No companies responded that copper wire is currently used in the majority of their products.



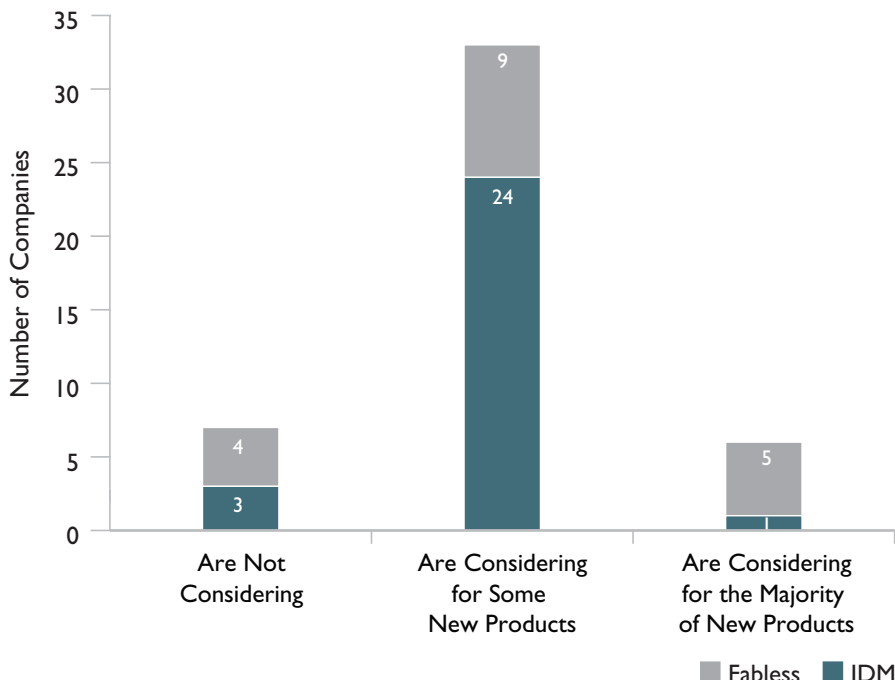
### Question 3

#### 3. To what degree is your company considering a switch from gold to copper wire in new product/package developments in the next three years? (Select the statement that most closely applies)

The majority of companies are considering a switch from gold to copper wire for some types of new products.

Seven companies will not use copper wire for new products, though two of those companies use and will continue to use flip chip technology. Thirty-three companies, the majority of surveyed respondents, are considering a switch from gold to copper wire for some of their new products.

Six companies are considering copper wire technology for a majority of their new products.



### Question 4

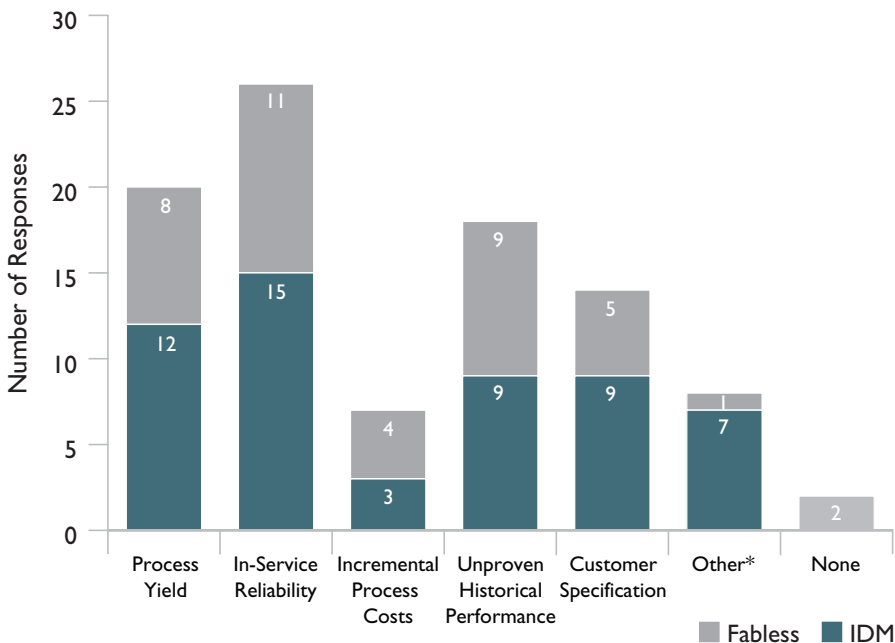
#### 4. What are the main issues or concerns that would prevent your use of copper wire technology in the future? (Select all that apply)

The main concern which would prevent the use of copper wire-technology in the future is in-service reliability, closely followed by process yield and unproven historical performance.

**\* Other**

- Performance concerns specific to the automotive market and the need to invest in new equipment
- Not suitable (copper) for the formation of complex wire loop shapes in advance packages
- (Company is) targeting flip chip
- High metal layer counts and complex pad structures in production are not designed for copper wire bonding
- Broad qualified supply base for gold wire bonding
- No cost of ownership benefit
- Difference in electrical performance between gold and copper wire, and existing manufacturing capacity

- Gold is very robust and allows for the reopening of packages for analysis.



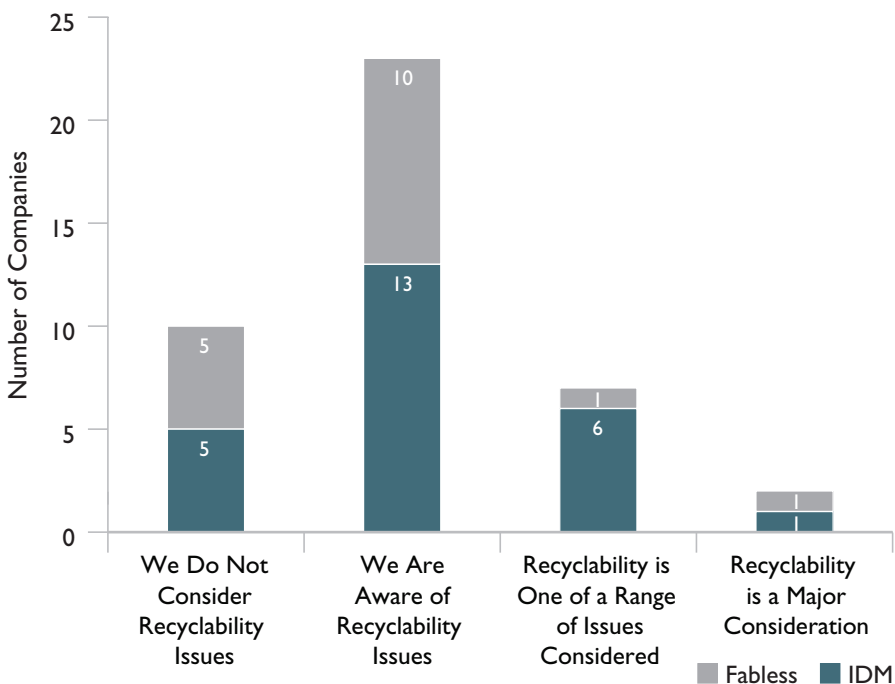
### Question 5

#### 5. To what extent is end-of-life recyclability (of waste electronics) a factor in your current bonding wire material selection? (Select the statement below which most closely matches your approach)

Only 21% of companies responding to this question consider end-of-life recyclability of bonding wire material.

A vast majority of the 42 companies responding to this question are aware of recyclability issues, though only nine companies (7 IDM/2 fabless) state that recyclability is “one of a range of issues” or a “major factor” considered.

Ten companies (5 IDM/5 fabless) responded that their companies do not consider recyclability issues.

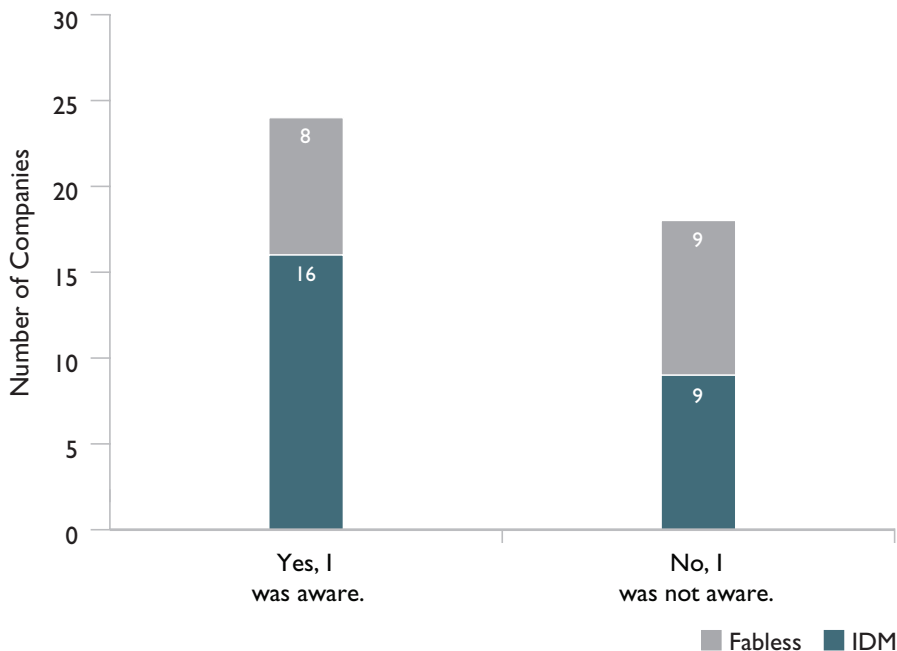


### Question 6

**6. It is estimated that over 50% of the economic value of some end-of-life electronic products is derived from the gold content of the waste. This value contributes to the economic viability of electronics recycling. Were you aware of this or not?**

Eighteen of the respondents were unaware of the value of gold in electronics recycling.

Awareness of the economic value of gold for some electronic products was more than half of 42 companies responding to Question 6. Of the 18 companies “not aware”, 12 are headquartered in North America.



### Summary

SEMI surveyed leading semiconductor companies to determine the extent of copper bonding wire programs in the industry and to identify the key issues and considerations related to decisions in selecting bonding wire material. The results of this extensive survey show that although many integrated device manufacturers and fabless semiconductor companies are considering the use of copper bonding wire for at least some product designs, there are still serious reservations in the industry over the use of this material, particularly due to concerns over in-service product reliability, and the unproven historical performance of copper wire bonding.

Surprisingly, although end-of-life recyclability of electronic goods is becoming an increasingly important issue, very few companies are aware of, or are influenced by, the important role the value of gold plays in the economic viability of waste electronics recycling.

### About the World Gold Council

The World Gold Council's mission is to stimulate and sustain the demand for gold and to create enduring value for its stakeholders. The organisation represents the world's lead-

ing gold mining companies, who produce more than 60% of the world's annual gold production in a responsible manner and whose Chairmen and CEOs form the Board of the World Gold Council (WGC).

As the gold industry's key market development body, WGC works with multiple partners to create structural shifts in demand and to promote the use of gold in all its forms; as an investment by opening new market channels and making gold's wealth preservation qualities better understood; in jewelry through the development of the premium market and the protection of the mass market; in industry through the development of the electronics market and the support of emerging technologies and in government affairs through engagement in macro-economic policy issues, lowering regulatory barriers to gold ownership and the promotion of gold as a reserve asset.

The WGC is a commercially-driven organisation and is focused on creating a new prominence for gold. It has its headquarters in London and operations in the key gold demand centres of India, China, the Middle East and United States. The WGC is the leading source of independent research and knowledge on the international gold market and on gold's role in meeting the social and economic demands of society.