TMT ANALYTICS

Misunderstood and mispriced

On track to meet development roadmap

On 20 September, 4DS Memory Ltd (ASX:4DS) updated the market on its collaboration with nanoelectronics R&D hub imec in Belgium (IMEC). The company indicated that upon analysis of the first batch of 300mm wafers from IMEC, it had identified several required process modifications. This update wasn't well-received by investors, judging by the more than 40% share price decline on the day of the announcement.

However, as the company has previously indicated, its collaboration with IMEC to migrate 4DS' interface switching ReRAM technology from lab to fab would require multiple iterations to the manufacturing processes to achieve the optimum set of memory cell and memory chip characteristics.

IMEC is the interim step on the way to commercial production

One of IMEC's core competencies is to help semiconductor companies, such as 4DS, transfer its R&D fabrication processes to production-compatible manufacturing processes.

The equipment used in IMEC's facilities is essentially the same equipment as used in commercial high-volume fabs. If 4DS demonstrates their memory technology is manufacturable at IMEC's facilities, using commercially available state-of-the-art semiconductor equipment, the company can then engage in commercial discussions with potential licensees or strategic partners.

Migrating from lab to fab is not simply copy/paste

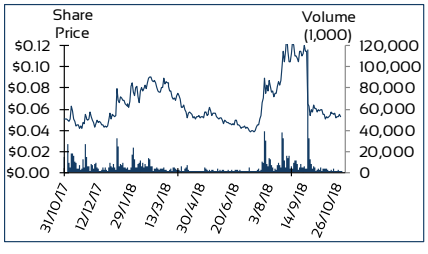
For 4DS, the key point of working with IMEC is (i) to develop a transferable production-compatible process flow for its Interface Switching ReRAM technology, (ii) to demonstrate this process on IMEC's megabit test chip, and (iii) to collect statistically significant and meaningful data on yield, speed, endurance and data retention for high-volume memory makers to base their licensing or acquisition decisions on.

But fabricating memory cells in an R&D lab is very different from manufacturing multiple wafers using state-of-the-art semiconductor manufacturing equipment at IMEC, let alone manufacturing in a commercial setting where processing speed and up-time is essential.

Equipment differences may lead to process differences

Different semiconductor manufacturing tools may need slightly diffe-

Number of shares (m)	964.6
Number of shares FD (m)	1086.8
Market capitalisation (A$ m)	51.1
Free Float (%)	100%
12 month high/low A$	0,115/0,018
Average daily volume (1,000)	5,873



Flash Note

4DS Memory Ltd.

ASX:4DS

Semiconductors & Semiconductor Equipment

Australia

Risk: High

4DS Memory (ASX:4DS) is a semiconductor development company aiming to provide an enterprise grade storage memory for cloud and data center storage markets. The company is developing a proprietary Interface Switching ReRAM technology leveraging expertise from a strategic partnership with a leading data storage player.

BUY

Current price: A$ 0.053

Price target: A$ 0.11

1 November 2018

Analyst: Marc Kennis
marc.kennis@tmt-analytics.com.au
+61 (0)4 3483 8134

rent processes to achieve the same specifications. Variations in temperatures, exposure times, etc. may lead to variations such as uniformity of layers, crystallinity (the way atoms and molecules are arranged) of the materials used etc.

Additionally, IMEC's expensive production-level fabrication equipment uses 300mm wafers (which is the standard wafer diameter for high-volume, high-density semiconductor fabrication) while 4DS' more affordable R&D equipment uses smaller wafer sizes. To process wafers of a larger size in high volume requires different tools. Even if a specific process step were similar in nature, the simple fact that the wafer is larger, and the tool is different may require tuning of several production processes.

Therefore, it is near-impossible to get a technology transfer from lab to fab fully optimized the first time around. The transfer process typically requires a few iterations and they were planned for in the IMEC agreement. 4DS expects the next batch of wafers from IMEC in 1Q 2019 (March quarter).

4DS' design to be mounted on IMEC's megabit memory vehicle

Once 4DS and IMEC complete the memory technology transfer to 300mm commercially available semiconductor manufacturing tools, the next step will be to mount this memory technology on IMEC's standard megabit memory vehicle with all the required circuitry to connect memory cells using 4DS' interface switching ReRAM technology to the outside world.

Integrating the memory cells with the megabit memory vehicle is done in back-end-of-line (BEOL) processes, which is the latter stage of the chip manufacturing process. BEOL is not to be confused with the back-end/packaging process, which involves cutting individual chips from the wafer, soldering electrical leads and packaging them using black resin or plastic.

Compared to transferring the core chip design from lab to fab, integrating this design with IMEC's megabit memory vehicle should be relatively straightforward given IMEC has done this numerous times and the platform is a standard design.

It will require some rigorous testing, though, specifically for yield, speed, endurance and retention. With all memory cells in a memory chip, they are accessible and testable at standard memory speeds – rather than individually as is the case in 4DS' lab setting.

Completion of technology transfer is the final hurdle before commercialization

In our view, completion of these steps will be required before commercialization can commence or a trade sale can take place as prospective licensees or potential acquirers of the company will want to see the technology working in a megabit memory.

Whoever licenses or buys the technology will likely want to further fine-tune the technology for specific applications. E.g. a memory manufacturer will want to tweak the technology further to suit a specific memory application, such as data-center or smart phone.

However, this further fine-tuning is beyond 4DS' current scope of work as the company envisions any prospective licensee or acquirer will conduct their own final tweaking of the technology.

Buy rating reiterated

We believe 4DS' technology transfer process has not been well-understood by the market, judging by the share price response to the 20 September announcement. In our view, the company is on track to deliver megabit memory vehicle results and a licensable

production-compatible process flow to the semiconductor industry within the next 12 to 18 months. Alternatively, a trade sale should be possible as well.

As such, we believe the company's current valuation doesn't do justice to the prospect of 4DS licensing or selling the technology within the next 12 to 18 months. Furthermore, as illustrated in Figure 1, peers such as BluGlass (ASX:BLG) and BrainChip (ASX:BRN), which are at a similar stage of development (BLG) or slightly ahead (BRN), are valued at more than twice 4DS' current valuation. For these reasons we reiterate our Buy recommendation for 4DS as well as our price target of A$ 0.11 per share.

FIGURE 1: VALUATIONS OF ASX-LISTED SEMICONDUCTOR COMPANIES

Company	Code	Semiconductor sub sector	Share price	Market cap (A$ M)
Weebit Nano	WBT	Filamentary ReRAM	0.029	46.2
Strategic Elements	SOR	Printable memory ink	0.057	13.8
BluGlass	BLG	Semiconductor equipment	0.255	106.8
Brainchip	BRN	Artificial Neural Networks	0.125	123.0
4DS Limited	**4DS**	**Interface Switching ReRAM**	**0.053**	**51.1**

Source: TMT Analytics

GENERAL ADVICE WARNING, DISCLAIMER & DISCLOSURES

The information contained herein ("Content") has been prepared and issued by TMT Analytics Pty Ltd ABN 17 611 989 774 ("TMT Analytics"), an Authorised Representative (no: 1242594) of BR Securities Australia Pty Ltd. ABN 92 168 734 530, AFSL 456663. All intellectual property relating to the Content vests with TMT Analytics unless otherwise noted.

DISCLAIMER

The Content is provided on an as is basis, without warranty (express or implied). Whilst the Content has been prepared with all reasonable care from sources we believe to be reliable, no responsibility or liability shall be accepted by TMT Analytics for any errors or omissions or misstatements howsoever caused. Any opinions, forecasts or recommendations reflect our judgment and assumptions at the date of publication and may change without notice. TMT Analytics will not accept any responsibility for updating any advice, views, opinions or recommendations contained in this document. No guarantees or warranties regarding accuracy, completeness or fitness for purpose are provided by TMT Analytics, and under no circumstances will any of TMT Analytics, its officers, representatives, associates or agents be liable for any loss or damage, whether direct, incidental or consequential, caused by reliance on or use of the Content.

GENERAL ADVICE WARNING

The Content has been prepared for general information purposes only and is not (and cannot be construed or relied upon as) personal advice nor as an offer to buy/sell/subscribe to any of the financial products mentioned herein. No investment objectives, financial circumstances or needs of any individual have been taken into consideration in the preparation of the Content.

Financial products are complex, entail risk of loss, may rise and fall, and are impacted by a range of market and economic factors, and you should always obtain professional advice to ensure trading or investing in such products is suitable for your circumstances, and ensure you obtain, read and understand any applicable offer document.

DISCLOSURES

TMT Analytics has been commissioned to prepare the Content. From time to time, TMT Analytics' representatives or associates may hold interests, transact or hold directorships in, or perform paid services for, companies mentioned herein. TMT Analytics and its associates, officers, directors and employees, may, from time to time hold securities in the companies referred to herein and may trade in those securities as principal, and in a manner which may be contrary to recommendations mentioned in this document.

TMT Analytics receives fees from the company referred to in this document, for research services and other financial services or advice we may provide to that company. The analyst has received assistance from the company in preparing this document. The company has provided the analyst with communication with senior management and information on the company and industry. As part of due diligence, the analyst has independently and critically reviewed the assistance and information provided by the company to form the opinions expressed in the report. Diligent care has been taken by the analyst to maintain an honest and fair objectivity in writing this report and making the recommendation. Where TMT Analytics has been commissioned to prepare Content and receives fees for its preparation, please note that NO part of the fee, compensation or employee remuneration paid will either directly or indirectly impact the Content provided.

RECOMMENDATIONS

TMT Analytics' issues a BUY recommendation in case of an expected total shareholder return (TSR, share price appreciation plus dividend yield) in excess of 25% within the next twelve months, an ACCUMULATE recommendation in case of an expected TSR between 5% and 25%, a HOLD recommendation in case of an expected TSR between -5% and +5% within the next twelve months and a SELL recommendation in case of an expected total return lower than -5% within the next twelve months.