

## Table of Contents

<b>1. Report Scope.....</b>	<b>9</b>
<b>2. Report Highlights .....</b>	<b>9</b>
<b>3. Market Overview .....</b>	<b>10</b>
<b>3.1 Key Factors Influencing the Semiconductor Industry &amp; CMP .....</b>	<b>10</b>
<b>3.2 TECHCET Wafer Forecasting Model: .....</b>	<b>21</b>
<b>3.3 450mm Conversion .....</b>	<b>24</b>
<b>4. CMP Slurries.....</b>	<b>25</b>
<b>4.1 Executive Summary: CMP Slurry Market .....</b>	<b>25</b>
<b>4.2 Slurry Business Environment .....</b>	<b>27</b>
<b>4.3 Slurry Business Dynamics by Slurry Type .....</b>	<b>33</b>
<b>4.3.1 ILD Slurry.....</b>	<b>33</b>
<b>4.3.2 Selective STI (S-STI) Slurry .....</b>	<b>34</b>
<b>4.3.3 Tungsten Slurry .....</b>	<b>35</b>
<b>4.3.4 Copper &amp; Barrier Slurry.....</b>	<b>36</b>
<b>4.3.5 TSV Slurry .....</b>	<b>37</b>
<b>4.3.6 Metal Gate (HkMG) Slurry .....</b>	<b>38</b>
<b>4.3.7 Polysilicon Slurry .....</b>	<b>39</b>
<b>4.4 3D Structures Process Considerations .....</b>	<b>40</b>
<b>4.5 Emerging Applications .....</b>	<b>43</b>
<b>4.6 Abrasive Supplier Business Environment.....</b>	<b>43</b>
<b>4.7 Supply Chain Issues Reality Check .....</b>	<b>44</b>
<b>4.8 CMP Slurry IP.....</b>	<b>45</b>
<b>4.9 CMP-Slurry Market Assessment &amp; Outlook.....</b>	<b>45</b>
<b>4.9.1 CMP-Slurry Pricing Trends.....</b>	<b>45</b>
<b>4.9.2 CMP Slurry and Asia .....</b>	<b>46</b>
<b>4.9.3 3-5 Year Outlook.....</b>	<b>46</b>
<b>4.10 CMP Abrasive and Slurry Suppliers Profiles .....</b>	<b>47</b>
<b>4.10.1 Ace Nanochem Co, Ltd.....</b>	<b>50</b>
<b>4.10.2 Adcon Lab, Inc.....</b>	<b>51</b>
<b>4.10.3 Air Products and Chemicals – now Versum Materials .....</b>	<b>51</b>
<b>4.10.4 Anji Microelectronics Co., Ltd.....</b>	<b>52</b>
<b>4.10.5 Asahi Glass Company, Ltd.....</b>	<b>52</b>
<b>4.10.6 Baikowski .....</b>	<b>53</b>
<b>4.10.7 BASF SE .....</b>	<b>53</b>
<b>4.10.8 Cabot Corporation.....</b>	<b>54</b>
<b>4.10.9 Cabot Microelectronics Corporation .....</b>	<b>54</b>
<b>4.10.10 Cheil Industries Inc. .....</b>	<b>56</b>
<b>4.10.11 Dongjin SemiChem Company, Ltd.....</b>	<b>57</b>
<b>4.10.12 Dow Electronic Materials.....</b>	<b>57</b>
<b>4.10.13 Eka Chemical.....</b>	<b>59</b>
<b>4.10.14 Elkem AS.....</b>	<b>59</b>

4.10.15	Eminess Technologies, Inc.....	59
4.10.16	Entegris.....	60
4.10.17	Evonik Industries AG .....	60
4.10.18	Ferro Corporation.....	61
4.10.19	FujiFilm Planar Solutions, LLC.....	61
4.10.20	Fujimi Incorporated .....	63
4.10.21	Fuso Chemical Company, Ltd. ....	65
4.10.22	W.R. Grace & Company.....	65
4.10.23	General Engineering and Research.....	65
4.10.24	Hitachi Chemical Co., Ltd. ....	67
4.10.25	Innovative Organics.....	68
4.10.26	Intersurface Dynamics.....	68
4.10.27	JGC Catalysts & Chemicals .....	68
4.10.28	JSR Micro, Inc.....	69
4.10.29	KC Tech Company, Ltd.....	69
4.10.30	Kemesys (acquired by Technic Inc.).....	70
4.10.31	Merck KGaA/EMD .....	70
4.10.32	Mitsui Mining & Smelting Company, Ltd.....	70
4.10.33	Nalco (An Ecolab Company).....	71
4.10.34	NanoPhase Technologies Corporation .....	71
4.10.35	Nissan Chemical Industries, Ltd.....	71
4.10.36	Nitta Haas Incorporated .....	72
4.10.37	Precision Colloids, LLC .....	72
4.10.38	Rhodia SA (Solvay SA).....	72
4.10.39	Showa Denko KK.....	73
4.10.40	Silbond Corporation .....	73
4.10.41	St-Gobain SA .....	73
4.10.42	Soulbrain Co. Ltd. (formerly Techno Semichem Company, Ltd.).....	74
4.10.43	UK Abrasives, Inc.....	74
4.10.44	Universal Photonics, Incorporated .....	74
4.10.45	UWiZ Technology Co., Ltd. .....	75
4.10.46	Wacker Chemie AG .....	75
4.10.47	Versum Materials ( see Air Products) .....	75
<b>4.11</b>	<b>Mergers and Acquisitions.....</b>	<b>75</b>
<b>5.</b>	<b>CMP Pad Suppliers .....</b>	<b>78</b>
5.1	Executive Summary Pad Market - 2017 .....	78
5.2	The CMP Pad Market.....	78
5.3	Pad Design .....	86
5.4.	Pad Patents .....	87
5.5.	Subpads .....	88
5.6.	CMP-Pad Market Assessment & Outlook.....	89
5.7.	Supply Chain Challenges.....	89
5.8.	Pricing Trends.....	90
5.9.	CMP Pad Suppliers Chart .....	92

<b>5.10. CMP Pad Suppliers .....</b>	<b>93</b>
5.10.1 3M .....	93
5.10.2 Cabot Microelectronics Corporation.....	93
5.10.3 Dow Electronic Materials.....	95
5.10.4 Eminess Technologies Inc.....	97
5.10.1 FNS TECH.....	97
5.10.2 Fujibo Holdings, Inc. ....	98
5.10.3 IV Technologies Co., Ltd.....	98
5.10.4 JSR Micro, Inc. ....	99
5.10.5 KPX Chemical Co., Ltd.....	99
5.10.6 NexPlanar Corporation/Cabot Microelectronic Corporation .....	100
5.10.7 Nitta-Haas Incorporated.....	100
5.10.8 Planar Labs Corp. ....	101
5.10.9 Rogers Corporation .....	101
5.10.10 Sekisui Voltek.....	102
5.10.11 Spartan Felt Company.....	102
5.10.12 Thomas West Incorporated .....	102
5.10.13 Toray Industries, Inc. ....	103
5.10.14 Toho Engineering Co., Ltd.....	103
5.10.15 Toyo Tire & Rubber Co., Ltd. (existing business) .....	103
5.10.16 Toyobo Company, Ltd.....	104
5.10.17 Others .....	104
<b>7. REFERENCES for the Reader: .....</b>	<b>104</b>

## List of Figures

Figure 3.1: Global Semiconductor Market: source WSTS May 2017.....	10
Figure 3.2: Increasing Impact of Materials Innovation on Chip Performance .....	12
(Source: Semico Research).....	12
Figure 3.3: Number for CMP steps per Advanced Node.....	13
(Source is Sematech Surface and cleaning Conference April 2015).....	13
Figure 3.4: Images of 2D NAND and 3D NAND .....	14
Figure 3.5: 3D X-point.....	15
Figure 3.6: New Fabs and lines starting Operations 2017 -2020 .....	16
Figure 3.7: Semiconductor Imports (source TECHCET China Briefing) .....	17
Figure 3.8: Internet of Things Install base, in billions of units .....	19
Figure 3.9: TECHCET 2017 Annual Wafer Starts (200mm equivalents) .....	22
Figure 3.10: 2017 Forecast: CMP Wafer Passes per Year .....	23
Figure 4.1: 2017 Slurry Revenue Forecast by Application.....	27
Figure 4.2: Slurry Volume at Point of Use .....	28
Figure 4.3: Overall CMP Slurry Usage Market.....	29
Figure 4.4: CMP Slurry Market Shares Overall .....	31
Figure 4.5: Slurry Revenue Market Shares by Process – 2017&2021.....	32
Figure 4.6: CMP Slurry Market Share ILD.....	33
Figure 4.7: CMP Slurry Market Share – S-STI.....	34
Figure 4.8: CMP Slurry Market Share – Tungsten .....	35
Figure 4.9: CMP Slurry Market Share – Copper.....	36
Figure 4.10: CMP Slurry Market Share – Copper Barrier.....	37
Figure 4.11: MEMS CMP Cross Section.....	40
Figure 4.12.: FinFET vs. Planar Transistor.....	41
Figure 4.13: IMEC SRAM Cells.....	41
Figure 4.14: Sub 14nm CMP Processes.....	42
Figure 4.15: GE&R Nano-Contact Release Capsules (nano-CRC) for CMP Slurries .....	66
Figure 5.1: CMP Pad Revenue by Process Type 2016-2021 .....	79
Figure 5.2: 2017 CMP Pad Market Shares .....	80
Figure 5.3: Pad Revenue by Wafer Size - all process .....	81
Figure 5.4: Pad Revenue for 300mm by Process Type .....	82
Figure 5.5: Pad Revenue for 200mm by Process Type .....	83
Figure 5.6: Pad Usage (Number of Pads) Forecast by Process Type .....	84

## List of Tables

Table 3.1: Internet of Things Units Installed Base by Category (Millions of Units) .....	18
Table 3.2: Internet of Things Units Installed Base by Category (Millions of Units) .....	18
Table 4.1: 2017 TAM for Slurry and Abrasive Suppliers.....	26
Table 4.2: CMP Abrasive Suppliers .....	47
Table 4.3: CMP Slurry Suppliers .....	49
Table 5.1: 2017 Forecast: CMP Pad Revenue in US\$ Millions.....	79
Table 5.2: 2017 CMP Abrasive and Slurry Suppliers .....	92