

Summary Analysis of SCME Reports related to Core Competencies in Microsystems Technologies

National Resource Center for Materials Technology Education
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This report provides analysis for the data presented in two reports developed by Southwest Center for Microsystems Technologies. One report on *Knowledge and Skills Needed by MEMS Technologists* (referred here as the MEMS report) consisted of an international survey of over 100 respondents from 5 continents on skills needed by technicians working on MicroElectroMechanical (MEMS) systems. The second report is *Needs Assessment, Manufacturing Technology SmallTech Program* (referred to as SmallTech), a New Mexico-based study of needs in 20 small technology companies in the broader area of microtechnology.

In general, these reports validate MatEd's basic core competency study. They also incorporate a number of specific technology areas related to microtechnology could be added in a future survey. Unfortunately, these data are not extensive enough or explicit enough to be able to add directly to our study.

MatEd's goal is to add competencies relevant to both micro and nano-systems technology systems, both of which have a lot in common with each other and with basic materials technologies. Competency categories in these areas need to be chosen carefully to focus on the real core competencies and specific performance indicators needed by technicians. The microtechnology categories used in these SCME surveys are more related to specific processes rather than being basic competencies, and are not specific relative to the competency involved. For example, deposition processes including PVD, CVD and electro-deposition are listed as categories, but the specific performance indicators are not provided. Should the technician know what they are, or should they be able to perform these processes? Determining these specifics and related specifics requires direct input from professionals in the area who do the hiring and supervision of technicians.

A listing of specific technical focus areas in each report is given below. These areas will serve as a starting place for developing specific competencies and performance indicators for technicians working in these fields. More general "soft" skills were also included in these studies, but data in the MatEd core competency report is more specific relative to proficiencies and skills. The data from these reports does not add additional information, therefore is omitted here.

1. MEMS report Process microsystem technology areas of greatest importance:

These data come from an industry survey by SCME (2006) with 106 respondents from 5 continents and 21 US states, with 85% male, and 15% female respondents. R and D shops represented 38% of respondents, with the balance being from fabrication, design or sales of MEMS, including BioMEMS systems. These items were

rated on a scale of 1 – 10, with 1 being the most important. Reported values noted are approximate since they are read off the report graphs (probably +/- .02 in value).

1	Characterization and final testing	3.5
2	Photolithography	3.8
3	Etch	4.0
4	Microsystem design	4.0
5	Thin film deposition	4.0
6	Packaging	4.0
7	Reliability and failure analysis	4.1
8	Wafer bonding	4.6
9	Electroplating	5.5
10	Electro-deposition	5.8
11	Molding	6.4
12	LIGA	7.0
13	Crystal growth and doping	7.5
6	Problem solving experience	3.3
7	Technical reading and comprehension	3.4
8	Technical writing	4.0
9	Presentation skills	4.2

2. Small Tech Report Science, Technology, Engineering and Mathematics areas.

Reported values noted are approximate since they are read off the report graphs (probably +/- .02 in value). Here 1 is most important and 6 is least important from 20 respondents:

1	Chemical Safety and Laboratory Protocol	1.6
2	Quality Assurance (TQC, SPC, Yield, statistics)	1.7
3	Advanced Manufacturing Operations	2.0
4	Metrology (Applied Measurement)	2.0
5	Visual Inspection	2.1
6	Math: Intermediate - Geometry, Trigonometry, Algebra	2.2
7	Physics: Introductory - Theory and Lab (Optics,	2.3
8	Electricity	2.3
9	Materials Science	2.3
10	Troubleshooting Process Equipment	2.3
11	Photonics - Electro Optics, Lasers	2.4
12	Digital and Analog Electronics	2.4
13	Chemistry: Introductory - Theory and Lab	2.5
14	Vacuum Technology	2.6
15	Math: Advanced - Calculus and/or higher	2.8
16	Gas flow pneumatics and Vacuum systems	2.9
17	RF Plasma systems	3.6
18	Robotics Handling Systems	3.7
19	Biochemistry: Introductory - Theory and Lab	4.0

20	Biology: Introductory - Theory and Lab	4.2
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Other areas of focus discussed but not rated included

- Attention to detail
- Ability to understand a problem and organize/invent means for solving it
- Ability to communicate problem needs
- Ability to implement a plan for solving a problem

3. Small Tech Report process knowledge relating to specific technologies:

Reported values noted are approximate since they are read off the report graphs (probably +/- .02 in value). Here 1 is most important and 6 is least important from 20 respondents:

1	Reliability and Failure Analysis	2.0
2	Device/Product Characterization and Final Testing	2.3
3	PVD - Physical Vapor Deposition (Evaporation)	2.5
4	Wet Chemical Etching	2.5
5	Photolithography	2.6
6	Lift Off	2.6
7	Material Properties	2.8
8	Thin Film Deposition (General)	3.0
9	Packaging	3.1
10	CVD - Chemical Vapor Deposition	3.3
11	Dry Plasma Etching	3.3
12	Microsystems Design Principals	3.6
13	Wafer Bonding	3.7
14	Electroplating	3.6
15	Electro Deposition	4.0
16	Crystal Growth	4.3
17	LIGA – (German acronym for high aspect ratio x-ray lithography)	4.3
18	Molding (injection molding, plastic embossing...)	4.6

Other areas not rated but discussed include:

- design of experiments
- cleanroom procedures
- surface physics
- SEM, STEM AFM and STM training
- device and IC processing

References:

1. Knowledge and Skills needed by MEMS technologists as Ascertained by Industry Survey and Job Profiling, L.A. West and M.W. Pleil, Southwest Center for Microsystems Education, 2006

2. Needs Assessment, Manufacturing Technology SmallTech Program, M.W. Pleil, Southwest Center for Microsystems Education, 2008