

Job Description

JOB TITLE:	Nanofabrication Process & Characterization Engineering Manager	DATE:	October 19, 2016
REPORTS TO:	Director, Quantum NanoFab		
JOBS REPORTING:	3 Nanofabrication Process Specialist/Engineers (USG 12: 1 existing + 2 future CFREF hires) 1 Electron Beam Lithography Senior Scientist (USG 11) 2 Quantum NanoFab Development EIT's (co-op students, 2 per term) 1 Characterization Scientist/Technologist (September 2017)		
LOCATION:	Main Campus		
GRADE:	USG 13		
DEPARTMENT:	Institute for Quantum Computing		

PRIMARY PURPOSE: The Nanofabrication Process Engineering Manager is a professional level member of staff, responsible for leading nanofabrication process technology development & maintenance for all lab equipment located in the Quantum NanoFab Core Infrastructure. This position plays a critical role in the success of the open access facility by directing the assessment, development and maintenance of complex fabrication processes and technologies within the facility. The Quantum NanoFab is unique in that it enables the fabrication of leading edge quantum and nano structures and devices. It serves the needs of two institutes, the Institute for Quantum Computing (IQC) and the Waterloo Institute for Nanotechnology (WIN), as well as multiple local startups and national industrial & academic clients. At any given time the facility's customer base includes over 200 independent and demanding users (composed of Post Docs, graduate students & private researchers) under 30 to 50 Principal Investigators. The facility's annual operating budget is on the order of \$1M; approximately \$500k in user fees are invoiced annually. It is one of the best equipped and advanced cleanroom labs in North America, containing a comprehensive suite of state of the art lithography, deposition, diffusion, etch, packaging and characterization equipment distributed throughout its cleanroom and satellite labs. In particular, the Quantum NanoFab contains an Electron Beam Lithography toolset that is unparalleled in Canada, a technology that is critical in the fabrication of quantum and nanoscale devices. The broad range of leading edge fabrication technologies enables researchers to conduct research at the highest international level. The highly specialized nature of these technologies make it imperative that the incumbent maintain an up-to-date knowledge of emerging equipment and process technologies to provide the greatest possible value to the facility's end users. This position leads a team of engineering professionals and scientists in making up to date nanofabrication process knowledge, expertise and services available to the facility's large and diverse customer base.

KEY ACCOUNTABILITIES:

Include 3-4 key accountabilities of the role. These key accountabilities should reflect 80%-90% of "what the job does not the "how".

1.	<p>Know how: Technology leadership and relationship building</p> <p>The incumbent has the education, skills and experience needed to continuously augment his/her knowledge of complex, state of the art and continuously evolving nanofabrication technologies.</p> <ul style="list-style-type: none"> • Maintains a detailed understanding of nanofab equipment & advanced process technologies. Initiates and conducts in depth process development initiatives and attends & participates in international technical conferences such as the Electron, Photon and Ion Beam Technology and Nanofabrication conference (EIPBN), University Government Industry Micro/Nano Symposium (UGIM), etc. • Establishes and maintains relationships with nanofabrication equipment vendors as well as with scientific staff at other leading nanofab facilities across North America including the University of Alberta's NanoFAB, Brookhaven National Lab's Center for Functional Nanomaterials, University of Michigan's Lurie Nanofabrication facility, etc. • Via extensive specialized knowledge garnered from equipment vendors, conferences, other world-class institutions and ongoing self-driven education, leads the ongoing objective of continuously improving available nanofabrication process technologies to the overall benefit of the facility's lab members.
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	<ul style="list-style-type: none"> Applies detailed knowledge of lab user nanofabrication needs and advances in material processing technologies to assist the Director in the acquisition of new fabrication and metrology equipment, with a vision of strategically augmenting the capabilities of the Quantum NanoFab as a function of constantly evolving customer needs.
2.	<p>Problem solving: Nanofabrication process technology assessment, development and troubleshooting</p> <p>The incumbent has multiple responsibilities and accountabilities in regards to fundamental and advanced nanofabrication process technology permissions, development and troubleshooting.</p> <ul style="list-style-type: none"> Under her/his supervision, the incumbent's team evaluates and approves/adjusts/declines all proposed nanofab process technologies prior to permitting them in the Quantum NanoFab (requires continuous learning and specialized knowledge). The Team provides detailed guidance and expertise on a wide range of process technologies to the facility's entire membership. These range from simple characterization methods to complex multi-layer device fabrication process flows which make full use of the facility's vast range of thin film deposition, etch and patterning technologies. Serves as primary resource for lab members and the team of experts under her/his supervision for troubleshooting and solving issues across all nanofabrication process technology categories. This requires a commanding knowledge of these technologies and an in-depth understanding of the chemistry, physics and engineering concepts that form their foundation. A deep understanding of multiple characterization techniques (scanning electron microscopy, optical microscopy, ellipsometry, profilometry) is essential. Manages the process for recording and cataloguing existing lab member process flows. Manages the process for minimizing cross-contamination risks (or other) potentially presented by new process technologies. Incumbent may be called upon to intervene and prevent lab members from performing work which may damage or contaminate lab equipment. Tact & diplomacy in face to face or written interactions is essential. Manages the process for documenting materials permitted in each piece of equipment in the Quantum NanoFab. All fab equipment features a web-enabled list of acceptable substrate types & thin film materials. These lists are a critical component of the facility's reputation for stability as they aid lab members to identify appropriate equipment for their fabrication needs. Specifically, these lists play an important role in keeping non-approved materials from contaminating equipment; the ongoing maintenance of these is the incumbent's responsibility. Manages the process for selecting new fabrication recipes to be researched and developed for existing and new equipment. This requires interaction with equipment manufacturers and resident technical staff. Through the use of design of experiment (DOE) methodologies, the process engineering team under the incumbent's supervision sets, adjusts and monitors equipment operational parameters to establish robust process technology windows on all equipment. Incumbent is responsible for ensuring that recipes and process flows are fully documented and revision-tracked for record keeping and accurate communication. Consults with stakeholders of the Quantum NanoFab (Director, Principal Investigators & advanced HQP lab members) to confirm ongoing suitability of existing nanofab processes and the need for new ones. New processes may serve as baseline parameters for future and existing researchers. Routinely engages with existing and new leading edge equipment vendors to develop new & advanced nanofabrication processes. Oversees the creation of and revision-tracked documenting of standard operating procedures (SOP documents), and process recipe parameters & specifications (PROC documents) for all fabrication equipment using ISO 9000 QA standards as a guideline. Manages the process for admitting new chemicals and materials into the cleanroom. All new materials are vetted to ensure compliance with WHMIS legislation and correct handling procedures.
3.	<p>Problem Solving / Accountability: Equipment performance & stability</p> <p>The incumbent is responsible for establishing and continuously monitoring all nanofab equipment processing parameters to ensure consistent top performance of the entire toolset. This challenging and stressful task requires specialized and extensive knowledge of all nanofabrication equipment. It also requires the ability to analyze large amounts of data, identify and evaluate process drift patterns, assess risk, identify possible solutions and quickly initiate corrective actions.</p> <ul style="list-style-type: none"> Manages the creation and maintenance of Statistical Process Control (SPC) initiatives across all categories of nanofab equipment as needed to maintain their performance to the highest industrial standards. This entails the

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	<p>regular operation of equipment (running standard processes as well as new process recipes), and the tabulation & statistical analysis of run data and trends. The incumbent assigns processing and data acquisition/analysis responsibilities across the process engineering & characterization group under his/her direct supervision.</p> <ul style="list-style-type: none"> • Identifies and generates new standard nanofabrication recipes as needed to monitor the performance of lab equipment and in-house baseline process technologies. • Is accountable for the process of remedial actions and repairs when degradation of equipment performance is uncovered by SPC analysis. Interacts closely with and provides guidance to equipment maintenance & repair technical team to re-establish equipment performance to baseline performance levels prior to release for use. • Manages the process for escalation & remediation in severe equipment down situations. These are often high stress situations which the incumbent is expected to effectively manage for his/her entire team. • With input and support from the Director, establishes, maintains and enforces policies for equipment operation and the safe handling of materials.
4.	<p>Know how: Training of HQP</p> <ul style="list-style-type: none"> • Serves as resident expert in all areas of nanofabrication technology. This entails self-directed learning in order to continuously master the advanced features of an extremely broad range of state-of-the-art nanofabrication equipment. Documents and disseminates the results of these learnings to the entire community <u>of</u> Quantum NanoFab lab members. • Meets with new lab members to identify & flesh out fabrication needs. Guides members in the creation of device fabrication process flows that are best suited to their research. Directs researchers to the many resources made available to them in regards to existing equipment capabilities and baseline fabrication recipes and technologies with an aim of bringing them on board safely, quickly and effectively. • Provides new lab member orientation lectures (shared responsibility with Director). • Defines and implements fabrication technology training programs. Leads process engineering group in designing instructional material and courses to facilitate lab member training. • Provides hands-on training & qualification certification for lab members on select, advanced equipment platforms. • Provides demonstrations as required to ensure optimal equipment use. • With assistance from her/his team, instructs new lab members in cleanroom health and safety protocols. • Together with all members of the Quantum NanoFab team, enforces all health and safety guidelines in accordance with UW and facility protocols & policies.
5.	<p>Know How: People Management</p> <p>The incumbent supervises a team of dedicated professional and scientific staff. Fosters an open, collaborative, positive team environment to ensure the best possible technical performance of her/his team while maintaining an across-the-board attitude of service excellence and problem mitigation, ownership and resolution.</p> <ul style="list-style-type: none"> • Provides leadership and sets individual and team objectives and priorities. Provides ongoing guidance and review as needed to ensure timely completion of objectives. • Manages the process of annual staff performance appraisals, salary administration, promotions, re-classifications and disciplinary issues for process engineering and scientific staff under his/her supervision. • Provides opportunities for professional development for all members of his/her team. • With input & guidance from the Director, manages the process for recruiting highly qualified individuals for engineering and scientific positions within his/her team. • As the Quantum NanoFab grows, incumbent's team may be called upon to oversee the development of and delivery of nanofabrication services to external clients.
6.	<p>Accountability: Reporting</p> <ul style="list-style-type: none"> • Meets regularly with his/her immediate supervisor. Provides updates and discusses possible avenues for resolving complex issues. • Annually, incumbent submits a report of her/his team's previous year's key issues and achievements as well as team's objectives for the coming year. Report is included in the formal annual report issued by the Director. • May be called upon to present updates to IQC and WIN Boards of Directors & Scientific Advisory Boards. • May also be called upon to present at workshops or conferences.

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POSITION REQUIREMENTS:

If hiring today, what would be the minimum requirements?

- Education:** Minimum BEng degree or BSc in Engineering Physics (or comparable) degree must be complemented by PhD degree (in Engineering) or Masters degree (in Engineering) and equivalent experience.
- Experience:** Professional Engineering (PEng) designation from *Professional Engineers Ontario (PEO)* is a definite asset. Minimum 8 years experience developing and running advanced integrated circuit (IC) or MEMS nanofabrication processes in well-established, world-class industrial or academic device fabrication environments. Proven ability, solid hands-on and theoretical materials and semiconductor knowledge & experience. Extensive practical and applied knowledge and experience with state-of-the-art nanofabrication equipment. The incumbent must be intimately familiar with the operation and development of recipes run on all classes of equipment. Excellent demonstrated written & oral communication skills and exceptional interpersonal skills.
- Technical:** Broad experience with the operation and fine tuning of nanofabrication recipes on all types of Silicon / IC fabrication tools (UV lithography, E-beam lithography, high temperature furnace and rapid anneal, high vacuum deposition systems, PVD and CVD film deposition systems, wet process stations, plasma etch tools, device packaging, etc.). The incumbent must have a solid command of characterization techniques as required to diagnose silicon/IC & MEMS nanofabrication process issues (such as Electron Microscopy, Optical Microscopy, Stylus or Optical Profilometry, XPS or EDX Spectroscopies, Atomic Force Microscopy, Ellipsometry and X-ray Diffractometry). Experience with design of experiments (DOE) and analysis methodologies. Solid knowledge and application of chemical safety, gas safety, general lab safety and cleanroom hygiene best practices is essential. Expertise and command of GDS-II computer aided design software is essential.

MS Word	Excel	PowerPoint	Other
Excellent	Excellent	Intermediate	Substantial experience with industry standard GDS-II design software such as L-Edit or other equivalents is essential.

NATURE AND SCOPE:

- **Interpersonal Skills:** Service oriented, independent and flexible. Exceptionally positive, diplomatic and constructive attitude as required to effectively work with a large number of people with a broad range of experience, educational and cultural backgrounds, both within and outside the university. Internal contacts include Quantum NanoFab team members, UWaterloo staff, faculty members, graduate students, Co-op students and Post Docs. External contacts include professionals, suppliers, customers and visitors.
- **Level of Responsibility:** Responsible for supervising the process engineering and characterization group. Ultimately responsible for maintaining the performance of highly valuable equipment to top standards. Equipment value is on the order of \$21M, installed in a \$26M purpose-built state-of-the-art nanofabrication cleanroom facility. This position directs the creation/pioneering of complex processes in consultation with members of his/her highly qualified technical staff (MSc and PhD backgrounds) and HQP. This highly specialized job is completed with minimal supervision.
- **Decision-Making Authority:** The incumbent is expected to work independently and to make often difficult decisions regarding all process engineering tasks and initiatives. In complex or unfamiliar technical situations the incumbent is expected to seek assistance both within and outside the Quantum NanoFab team as required.
- **Physical and Sensory Demands:** Extensive time may be spent sitting in front of equipment, requiring focused observation. Much of the time is spent working in a physically taxing cleanroom environment where cleanroom gowning (head to toe) must be worn. Extended periods of time may be spent in yellow lighting conditions. Much of the work can be accomplished sitting in a comfortable position with frequent opportunity to move about. Occasional lifting (up to 40lbs) may be required.
- **Working Environment:** Long hours may occasionally be called for to run a given process under development from beginning to end with minimal interruptions or delays. There are deadline pressures, while at the same time there is a demand for thoroughness, accuracy and acute attention to detail. Incumbent may be asked to respond to facility emergencies after normal working hours.