TECHNICAL SPECIFICATIONS

FOR THE SUPPLY OF
A ‘PECVD by LIQUID SOURCE PRECURSOR’
FOR
SCUOLA SUPERIORE SANT’ANNA

ALLEGATO “A” – LOTTO 1
PROCEDURA APERTA IN LOTTI PER LA FORNITURA DI APPARECCHIATURE SCIENTIFICHE PER IL PROGETTO PIC

CUP: J55E12000200003

CIG: 5218182402

Index

INTRODUCTION 3

1. TECHNICAL SPECIFICATIONS: MINIMUM REQUIREMENTS 3

1.1 HARDWARE CONFIGURATION 3
1.2 PROCESS CONFIGURATION 4
1.3 CONDITIONS 8

2. TECHNICAL SPECIFICATIONS: EVALUABLE FEATURES 8

2.1 HARDWARE CONFIGURATION 8
2.2 PROCESS CONFIGURATION 8
2.3 CONDITION 9

3. INSTALLATION, ACCEPTANCE, DOCUMENTS, TRAINING 9

3.1 INSTALLATION 9
3.2 ACCEPTANCE 9
3.3 DOCUMENTS 9

4. APPENDIX 10

4.1 SUMMARY TABLE OF MINIMUM REQUIREMENTS 10
4.2 SUMMARY TABLE OF EVALUABLE FEATURES 12

INTRODUCTION

For integrated optical waveguide based on silicon and glass layers it is necessary to insulated the guiding structure bottom and top cladding . Doped and Un-doped Silicon Oxide layer play a key role for optoelectronics device processing . We identify the technology **P**lasma **E**nhanced **C**hemical **V**apor **D**epositions by **L**iquid **S**ource precursor in order to deposit dielectric layers suitable for filling sub micron structure with high aspect ratio , high conformity and have reflow characteristics to achieve planarization property .Due to the field of applications is relevant the control and the reproducibility of the refractive index in the range of applications 800 to 1600 nm .
Let summarize the main requirements of good deposit films :

- Not Hygroscopic for doped film
- Controlled shrinking
- Low stress
- Low particle count
- High Breakdown films
- Uniformity of thickness and composition
- Appropriate refractive index control
- Conformal and flow rate topography
- Appropriate etch rate and low dielectric constant .

Due the technology PECVD also gas reactant must be supplied to the process chamber , enable the technology to deposit Silicon Nitride and Silicon Dioxide layers by SiH_4 . The thin film properties are summarized :

- Low stress
- Low particle count
- High Breakdown films
- Uniformity of thickness and composition
- Appropriate refractive index control

Those film has the functions of capping layer and pure insulating applications.

1. Technical specifications: minimum requirements

1.1 Hardware configuration

- The equipment will be supply for 6 “ wafer diameter, the system must be up gradable up to 8”.
- The equipment will be installed “through the wall”
- According to the use of toxics gases all the safety devices, software and hardware interlocks must be provided .
- Mass flow and liquid tank should be purge and vent automatically in order to exchange or to access for standard maintenance procedure.
- All the gas line connections must be VCR type for safety reason.
- The equipment must be conformal to CE Standard and certified .
- The system must be equipped with 3 liquid source :TEOS, TMB,TMP. The size should be according the process requirements and all the safety tool in agreement with safety procedure .

- Liquid source definitions:
  TEOS Tetraethil Ortosilicate $Si(C_2H_5)_4$
  TMB Trimethilborate $B(OCH_3)_3$
  TMP iTrimethylphosphite $P(0CH_3)_3$ or TMPo Trimethilphosfate $PO_4(OCH_3)_3$
- Gas line up to 8 gas line and 7 mass flow according the process requirements, the Toxic gas lines must be equipped with bypass system (SiH_4 and NH_3). The gas and MFC line are the following: SiH_4,N_20,NH_3,CF_4,N_2,O_2 and N_2, one spare.
- The cleaning gas available are CF_4 and O_2
- Mechanical cleaning minimum after 750µm layer deposition
- Vacuum gauge for process control and hardware control
- Pumping system fully automated
- Abatement for pump exhaust tool must be provided and properly integrate to the equipment.
- Single wafer process chamber with flange for view port and for OE(Optical end point detection).
- Dry pump and process gate and throttle valve for process pressure control , all the pipe work with proper heating jacket to avoid particles deposition.
- Substrate electrode up to 400℃ +/- 2℃ across all surface. Minimum diameter 240 mm
- Top electrode with integrated shower head, easy to remove for maintenance and cleaning, the top electrode has connections for RF Power supplies (13 MHz and KHz or different RF solution) the top electrode heating system.
- Power generator 13.56 MHz with automatic RF tuning , maximum power ≥ 600W.
- Frequency set up for superior stress control for SixNy thin films deposition.
- Vacuum load lock with independent pump system.
- Automatic transfer system from LL to Process chamber.
- Optical end point emissions in the minimum range 200-800 nm for process control.
- All the system will be Computer controlled.

1.2 Process configuration

BPTEOS and TEOS from 3 liquid source (TEOS,TMB,TMP).

Main application is cladding for integrated photonic systems. Following the specifications about the film property part of the acceptance test.

- Temperature deposition: 200-350℃
- Temperatures Reflow : 850℃ 1100℃ Horizontal fur nace by SSSUP
- Film thickness depositions (as deposit) BPTEOS and TEOS

Thickness	uniformity within wafer	uniformity wafer to wafer
5000 Å	± 2%	± 3%
5 µm	± 2%	± 3%
20 µm	± 3%	± 5%

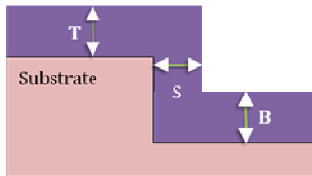
Measurements : $\frac{(Max - Min)}{2x\ (Mean\ Thickness)}\ x\ 100$

Instruments : Fimtek4000 or equivalent Supply by SSUP.

Edge exclusion: 2mm

Deposition rate : range 500 up to 3500 Å/min $Avarage\ thickess\ 9\ point \big/ depo\ time$

- Step Coverage BPTEOS and TEOS

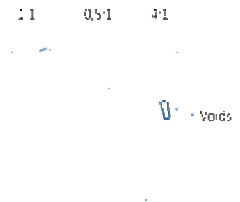


S(thickness)/T(thickness) >>85%

B(thickness)/T(thickness) >>85%

Method of measurements: SEM Cross sections supply by SSSUP.

- Gap Filling



Gap Filling	Distance between structure	Aspect ratio
No Voids	100 nm - 1.5 µ	>2,5 :1
No voids	1.5 µ-5	>4:1
	>5 up to 15 µ	>5.1

Method of measurements SEM Cross sections supply by SSSUP.

- Film stress

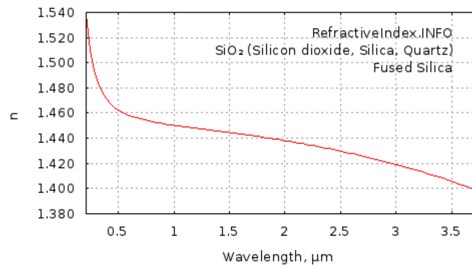
Stress measurements on 15µ layer deposit on Blank after anneal at 850 -1000 ℃ < ±200 Mpa

Measurements on Flexus KLA Tencor system or equivalent

- Refractive index .

The refractive index will be analyze on 20µm thick layer according the following dispersion curve. The layer doping compositions will be in agreement with n requirements .

The measurements will be performed after annealing (T and Time defined by supplier).



λ	n	Uniformity within the wafer %	Uniformity wafer to wafer %
638	1.4576	±0,0002	±0,0004
1310	1.4468	±0,0002	±0,0004
1550	1.44402	±0,0002	±0,0004

The measurements will be performed with Filmtek4000 or equivalent supply by SSUP

- BPTEOS doping compositions :

The layer compositions between B and P must be balance to fit all the specs and deposit stable films.

Target B Bulk film Wt% Boron 2-6,5 %

Target P Bulk film Wt% Phosphorus 3 -7%

Definitions : $\frac{Wt\ of\ particilar\ atom\ or\ melucule}{Wt\ of\ total\ sample}\ x\ 100$

Method of measurements:

X-ray Fluorescence EDX EDS, FTIR or mass spectroscopy by external labs .

- Particle

Particle could be generate by plasma system or by film instability and formations of hygroscopic material like BPO_4

Optical microscope 20X magnifications dark field . Diameter < 0.2-0.3 µ #/cm^2 TBD.

- Plasma cleaning

The plasma cleaning will be performed according the process gas available CF_4 /O_2

- Mechanical cleaning

Mechanical cleaning, meaning open process chamber, should be guaranteed at least after 750µm deposit layer.

The mechanical cleaning should be performed with easy access of process chamber and in accordance to safety procedure.

Si3N4 Layer property

Si3N4 layer or SixNy layer will be available and it will be part of qualifications and acceptance test protocol.

- Temperature depositions : 100℃ -350℃
- Film thickness depositions (as deposit)

Thickness	uniformity within wafer	uniformity wafer to wafer
500 Å	± 2%	± 3%
1500 Å	± 2%	± 3%
5000 Å	± 2%	± 3%

Measurements : $\frac{(Max - Min)}{2x\ (Mean\ Thickness)}\ x\ 100$

Instruments : Fimtek4000 or equivalent Supply by SSUP .

Edge exclusion: 2mm

Deposition rate : range 50 up to 100 Å/min $Avarage\ thickess\ 9\ point / depo\ time$

- Film stress

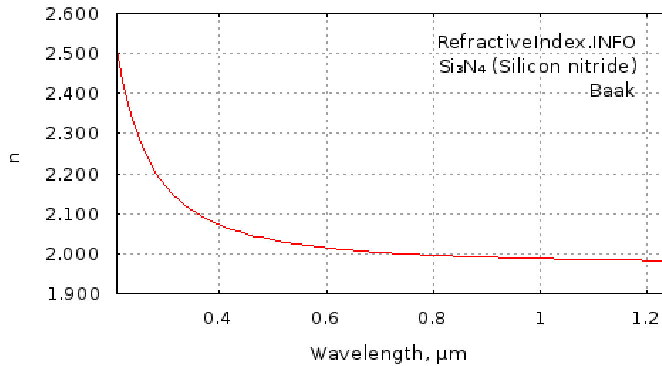
Stress measurements on 2000 Å layer deposit on Blank S< ±200 Mpa

Measurements on Flexus KLA Tencor system or equivalent

- Refractive index .

The refractive index will be analyze on 2000 Å thick layer according the following dispersion curve. The layer doping compositions will be in agreement with n requirements .

The measurements will be performed after annealing Time and Temperature to be define



λ	n	Uniformity within the wafer %	Uniformity wafer to wafer %
638	2.0108	±0,0002	±0,0004
1310	1.9944	±0,0002	±0,0004
1550	1.9890	±0,0002	±0,0004

The measurements will be performed with Filmtek4000 or equivalent supply by SSSUP

1.3 Conditions

- Conformity to CE standard and certification
- Availability of spare parts guaranteed for minimum 10 years
- Warranty 1 year
- Shipment and installation included to:
  Scuola Superiore Sant'Anna (TeciP Institute)
  Via Giuseppe Moruzzi 1
  56127 Pisa (Italy)

2. Technical specifications: evaluable features

2.1 Hardware configuration

- Chamber designed for gas shower exchange and wet cleaning
- System designed for reducing chamber wet cleaning frequency
- Abatement system based on dry bed chemisorption technology

2.2 Process configuration

- Better uniformity of deposited layers
- Higher BPTEOS deposition rate > 350 nm/min
- Better gap filling capability of annealed BPTEOS. Aspect ratio > 2.5:1 on 100nm-1.5um structures
- SixNy deposition at process temperature < 100℃

2.3 Condition

- Consumable spare parts kit for yearly ordinary maintenance
- One extra year warranty

3. Installation, acceptance, documents, training

3.1 Installation

Scuola Superiore Sant'Anna, by following the supplier directions, is in charge for: moving the crate from the track to the site, opening the package, tool positioning in the working area, connecting all the necessary facilities to the tool.

Supplier must check for the correct placement and connection, facilities presence, flow and pressure value. Execute the acceptance procedure, final and functionality test.

3.2 Acceptance

Installation and commissioning, followed by process start-up with demonstration of defined process specification must be performed onsite by the Supplier.

3.3 Documents

Supplier must:

1. Detail configuration of the equipment and list of parts and components
2. Deliver layout of installation and the list of the facilities required for a proper functioning of the tool.
3. Deliver process data according to our specs (paragraph 1.2).
4. Deliver procedures for standard operation and maintenance.
5. Deliver safety instructions
6. CE conformity declaration
7. Describe after sales service and support solution.

The compliance of the equipment to the minimum requirements and to the evaluable features must be evident in the documentation (1-7).

4. Appendix

4.1 Summary table of minimum requirements

The compliance of the equipment to the minimum requirements must be evident in the documentation (paragraph 3.3).

Summary configurations			
Parameter	Target Specs	Units	Note
Configurations	6”	Wafer size	
Up gradable	Up to 8”	Wafer size	
Installation type	Trough the wall	Type	
Safety interlock	According use Toxic gases	Type	
Gas Connections	VCR	Type	
Gas Lines	8	#	
Mass flow meter	7	#	
Mass flow by pass	2	#	Toxic gases
Gas type		Type	SiH_4,N_20,NH_3,CF_4,N_2,O_2 e N_2 spare
Liquid source	3	System	Including safety and deliverable
Liquid source	3	Type	TEOS Tetraethil Ortosilicate $Si(C_2H_5)_4$ TMB Trimethilborate $B(OCH_3)_3$ TMP iTrimethylphosphite $P(0CH_3)_3$ or TMPo Trimethilphosfat$PO_4(OCH_3)_3$
Liquid source change	1	Type	Automatic purging
Gas and liquid safety	1 system	Type	According chemistry
Process chamber	Compatible 8 “	Type	
Process chamber port	2 Flanges	Type	
Process chamber shower head	1	Type	Easy access for maintenance

Substrate heating system	350°C	°C	
RF MainPower supply	600	W	
RF Power Frequency	13.56	MHz	
Frequency set up for superior stress control	yes		Different RF solutions should be with fully automatic tuning system
Automatic matching network	1	type	For both Frequency
Pump System	1	Type	Fully Automatic
Process Pump	Dry	Type	
Heat jacket	1	Type	To avoid particle deposition
Load Lock	1	Type	
LL pump system	Dry	Type	
Transfer System LL process Chamber	Automatic	Type	
Vacuum gauges	system	Type	According process and safety
Optical end point Detections	System	Type	Fully automated
Optical End Point Detections Wg	200-800	Λ nm	
Abatement system	1	Type	According gas and process configuration
Controls	1	Type	All the equipments parts must be computer control
Process acceptance	**According paragraph 1.2**		
CE Marking	1	Type	
Training	1	Type	Included
Availability of spare parts	Minimum 10	years	

Warranty	1	year	
Service			Define after sale service and support solutions
Shipment	Included		Via Moruzzi 1 , Pisa , Italy

4.2 Summary table of evaluable features

The compliance of the equipment to the technical specification assessable as improvements must be evident in the documentation (paragraph 3.3).

4.2.1 Summary Evaluable Features (qualitative evaluation)			
Item	Parameter	Qualitative evaluation system	Max points
Configuration			
A.1	Chamber design for gas shower exchange and wet cleaning	Mechanical drawings, safety and operating procedure for chamber shower exchange and wet cleaning method are evaluated to determine the most functional design. Details must be present in the documentation (paragraph 3.3)	10
A.2	System designed for reducing chamber wet cleaning frequency	Technological improvements that determine a reduction of wet cleaning frequency are evaluated. They must be detailed, including cleaning frequency data, in the documentation (paragraph 3.3)	10
Process			
B.1	Better film uniformity within wafer	Film uniformity improvements, for defined materials Si_3N_4 and BPTEOS (see paragraph 1.2), are evaluated according to the documentation (paragraph 3.3 part 3)	5
B.2	Higher BPTEOS deposition rate	Deposition rate improvements, for BPTEOS (see paragraph 1.2), are evaluated. Process data must be detailed in the documentation (paragraph 3.3 part 3)	5
B.3	Better gap filling capability of annealed BPTEOS	BPTEOS gap filling improvements, better than minimum required (see paragraph 1.2), are evaluated according to details in the documentation (paragraph 3.3 part 3)	5
B.4	SiN deposition at process temperature below 100°C	SiN deposition with good properties at process temperature below 100°C, is evaluated. Process and film data must be detailed in the documentation (paragraph 3.3)	5
		MAX TECHNICAL POINTS (qualitative part)	40

4.2.2 Summary Evaluable Features (quantitative evaluation)			
Item	Parameter	Quantitative evaluation System	Max points
Configuration			
A.3	Abatement system based on dry bed chemisorption technology	If the parameter is absent = 0 If the parameter is present = max points	10
Condition			
C.1	Consumable spare parts kit for yearly ordinary maintenance	If the parameter is absent = 0 If the parameter is present = max points	8
C.2	One extra year warranty	If the parameter is absent = 0 If the parameter is present = max points	12
		MAX TECHNICAL POINTS (quantitative part)	30