



OPERAČNÍ PROGRAM PRAHA
KONKURENCESCHOPNOST



ADDITIONAL INFORMATION ON THE TENDER CONDITION Nr. 4

Contracting Authority: Fyzikální ústav AV ČR, v.v.i.
Seat: Na Slovance 2, 182 21 Praha 8
Identification No.: 68378271
Tax Identification No.: CZ68378271
Person authorized to represent the Contracting Authority: Prof. Jan Řídký, DrSc., Director

Public Contract name: MOVPE Apparatus

The Contracting Authority in accordance with § 49 of Act No. 137/2006 Coll., on Public Procurement, as amended (hereinafter the "Act"), announces the following additional information on the tender conditions relating to the public supply contract published in the Journal of procurement contracts under the registration number 479977.

Question 1:

Please can you specify the material and the size of the substrate?

Answer:

The substrates may be used in various, mostly will be used sapphire and silicon. Size 2 " and smaller.

Question 2:

Please can you specify the materials, the configuration and the size of the wafer?

Answer:

The substrate and the wafer is the same, see the answer to question 1).

Question 3:

We assume that the dispensing systems are available for all gases.

Answer:

Of course, the system has to include the flow meters, which control the precursors. Branch for SiH₄ must be supplemented by the dilution line. TMI_n, TMAI and CP2Mg branches must be heated. The carrier gas for each bubbler has to be switchable between N₂ or H₂.

Question 4:

What material and size of the samples is assumed?

Answer:

The material of the substrates was specified in the answer to question 1). Heterostructures prepared by epitaxy on the substrate will consist of the following semiconductor GaN, AlGaN, InGaN, AlGaInN, AlN and inn. The thicknesses of the individual layers will range from 1 nm to several microns.

Question 5:

Will be only a standard coating of wafers or to be also taking into account any irregular samples?

Answer:

Some increases will be prepared on substrates of non-standard sizes.



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Question 6:

Dimensions of the laboratory room (510x410x300 cm) are not common. Regarding the reactor is just OK, but put all the components incl. pumps, gas management, management, etc., in such a small volume is very challenging. Or something of that will be placed somewhere else?

Answer:

The complete MOVPE apparatus must fit to the laboratory room whatever equipment will need to run - and therefore the computer for the control of the epitaxial process, ammonia scrubber (NH₃, N₂ and H₂), devices for optical diagnostics and process monitoring any leakage of ammonia. Compressed gas cylinders shall be placed outside the room. For safety reasons, also remained free passage around the apparatus, the longest dimension should not exceed 420 cm devices.

The Contracting Authority in accordance with the above questions and answers added as an attachment refinement of technical specifications, which were included in the above answers for the increasing of the clarity for potential suppliers and interested parties. Likewise, it is an attachment with the updated table of technical specifications on the subject of performance. These annexes fully replaces the former Annex 5a-1 (Technical specifications) and 5a-2 (Technical specification table) that were attached to the additional information No. 2 of June 17 2014. Annex No. 5a-1 (Technical specifications) and Annex 5a-2 (Technical specification table) are now valid in this updated form.

The Contracting Authority also updated the following specifications for the **the part 1 of the procurement - MOVPE apparatus**, which are now valid in the following terms:

1.3 Term

Anticipated commencement: immediately after contract execution

Anticipated completion of part 1: within 8 months from contract execution

The LABONIT Project end on 30 June 2015 and all project activities must be completed by that date, including all purchases and installations of equipment.

3.5 Technical qualification criteria

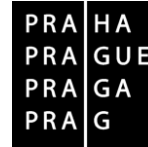
Fulfilment of the technical qualification criteria will be demonstrated by a bidder, who submits:

- a) according to § 56(1)(a) of the Act a list of important services or projects delivered by the bidder in the past 3 years, specifying their extent and the time over which they were provided. This list will be provided in the form of an affidavit and will contain information on the name of the Contracting Authority, project name, place and date of completion and the financial value of the supply within the project; the affidavit will be accompanied by
 - Certificate issued by a public contracting authority to that effect, if the services were provided to a public contracting authority, or
 - Certificate issued by any other person or entity if services were provided to a person other than a public contracting authority, or
 - Contract with other person / entity and document demonstrating performance by the bidder, if the confirmations required above cannot be obtained from such person due to reasons on their part.

An important project /service for part 1 hereof shall be considered as delivery of technology apparatus based on the organo-metallic epitaxy allowing preparation of nitride nano-hetero-structures in the financial value of at least 20 000 000,- CZK excl. VAT for one client. Bidders shall demonstrate implementation / delivery of at least three such important projects.



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b) In accordance with § 56(1)(e) of the Act, the bidders shall provide samples, descriptions or photographs of the goods / equipment to be supplied. The Contracting Authority requires concrete technical specification incl. A scheme of suggested system which would fulfil the technical requirements and a specification of the producer for all goods, which will be subject to delivery hereunder. Bidders shall also submit a filled in table providing technical specification as outlined in Annex No. 2a) of draft contract. The bidder has to provide **a sample** prepared on 2" sapphire wafer by the MOVPE apparatus of the same type which is supplied by supplier to demonstrate that offered apparatus complies quality requirements of the project. The structure must contain 10 x In_{0.13}GaN/GaN MQW structure with 2 nm QW thickness and 10 nm barrier thickness covered by 20 nm thick Al_{0.15}GaN capping layer. Following parameters of the sample are required: the thickness uniformity of layers better than 3%, composition deviation better than 2% and emission wavelength uniformity better than 5 nm over sample area excluding the region of 3 mm from the wafer edge.

9.9 In the case of Supplier's delay of the delivering of the subject of the performance (MOVPE apparatus) the contracting authority is entitled to charge a penalty of 0.01% of the total purchase price for each day of delay in delivery with a possible grace period of 3 weeks.

The Contracting Authority in a connection with the service updates of the terms prolonged the deadline for submission of bids for **the part 1 of the procurement - MOVPE apparatus** in accordance with § 40/3 of the Act. **The part 2 of the public contract - Chamber for removal of ammonia and metal-organics** have been canceled in accordance with § 84/1/e of the Act. There is a change in the wording of paragraph 2.2 of the tender documentation which is now valid as amended below:

2.2 Bids for part 1 of the tender shall be submitted no later than on **August 27, 2014** by **10:00 am** to the address of the Contracting Authority's seat at Na Slovance 1999/2, 182 21 Praha 8, Czech Republic, to the mail room at the ground floor by the main entrance (please use the entrance from Pod Vodárenskou věží 1 street). Bids may be delivered by any suitable means (mail, courier, personally, etc.) at the above address on business days between 7:30 am and 3:15 p.m. and on the last day of the submission period only **by 10:00 am**. Other methods of delivery shall not be considered to constitute a properly delivered bid.

In Prague

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Annexes:

5a-1) Technical specification for part 1 of the public contract

5a-2) Technical specification table for the subject matter for part 1 of the public contract



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Annex No. 5a-1 – Technical specification „MOVPE Apparatus“

The subject matter of the public contract is supply (acquisition) of an apparatus based on organo-metallic vapour phase epitaxy technology allowing preparation of nitride nanoheterostructures. The Apparatus construction shall use the latest knowledge allowing production of the highest quality nitride nanoheterostructures. Acquisition shall be understood as purchase, tailor-made solution / manufacture, delivery, installation and commissioning of the Apparatus. The Apparatus must comply with all technical and safety standard valid in the Czech Republic for this type of equipment. Performance hereunder includes handover of the complete documentation for the Apparatus.

Obligatory requirements:

- Apparatus must enable growth of high quality nitride semiconductors with broad band gap energy with the epitaxy growth temperature up to 1200 °C.
- Small size stainless steel vertical reactor construction designed for research and development application is required to decrease the energy and material consumption (working gas mixture flow rate through the reactor around 20slpm or less).
- The apparatus has to enable epitaxy under a low or atmospheric pressure. Dry pump with flow rate 120 m³ per hour is required for reactor pumping, the reactor pressure has to be controlled in the range 0.05 – 1 bar. The system has to keep the same pressure between Run and Vent lines of metalorganics to avoid pressure instability with Vent/Run switching of metalorganics.
- The introduction of carrier gas and precursor mixture into the reactor must have vertical alignment with homogeneous precursor concentration and flow over whole susceptor area. This geometry and similar construction is used in majority of industrial apparatuses and improves the homogeneity of the epitaxial layers.
- The distance of metal-organic entrance and the substrate has to be adjustable and computer controlled during the epitaxial process according to the required growth parameters (temperature and pressure) of different nitride compounds (AlGa₃N, GaN or InGa₃N).
- Precursors of the group III and group V elements have to enter the reactor separately.
- The reactor walls and the mixing manifold have to be cooled.
- The stainless steel gas piping with VCR connections are required. All piping, VCR and valves must have polished inner surface to minimize an adsorption of substances on the inner piping surface.
- Apparatus has to be equipped at least by 5 branches for metal-organic precursors (TMGa, TMI₃N, TMAI, DMHz, Cp₂Mg), and has to have preparation for at least 2 spare metal-organic lines. The lines for TMAI, TMI₃N and for Cp₂Mg has to be heated up to 60 °C to ensure sufficient concentration of metalorganics in the carrier gas. The carrier gas for each bubbler has to be switchable between N₂ or H₂. The metalorganic lines have to be equipped by the blinded connection for He leak detector.
- The TMI₃N line has to be equipped by the component measuring concentration of TMI₃N in line and controlling the flow rate through the MFC (closed loop).
- Apparatus must contain lines for at least 4 gas sources (NH₃, N₂, H₂ and SiH₄) and a preparation for one spared gas line. The SiH₄ has to be built as dilution line for layer doping.
- The apparatus must be equipped by the moisture sensor with sensitivity at least 1 ppb.
- One line purely for carrier gas with controlled flow rate is required for balancing the flow rate through the reactor.



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- The system should be equipped by at least 3 thermostatic water cooled baths for metal-organic cooling
- Rotary SiC coated graphite susceptor with resistive or radiofrequency heating is required for achieving high thickness and compositional homogeneity of the epitaxial layers.
- Whole epitaxial process together with valves, mass flow and pressure controllers have to be computer controlled to achieve sufficient accuracy for nanoheterostructure preparation.
- The system has to enable equipment by in situ monitoring of epitaxial process by measuring the temperature and curvature of sample during the epitaxial process. Three optical ports are necessary for this monitoring.
- The apparatus has to be compatible with European standard power supply 230/400 V, 50 Hz, 100 A per phase.
- The system has to be installed in the laboratory with size 510 x 410 x 300 cm (length x width x height). The size of the apparatus must not exceed the size 420 x 200 x 250 cm (length x width x height) to provide reasonable passage for the operational staff around the apparatus for safety reason and to provide sufficient space for necessary additional equipment in the laboratory (control computer, scrubber, gas purifiers, ammonia detection, necessary gas supply and extraction air tubing).
- The maximal load of the laboratory floor is 4.1 kN/m³. Any component of the apparatus must not exceed this value.
- The apparatus has to be delivered in parts (modules) in such a way that none of the part is exceeding the size 180 x 130 x 230 cm (length x width x height) due to the limited space for transportation of the apparatus in the building to the laboratory room.
- The apparatus has to be installed in a cabinet system with extraction air possibility for safety reason.

Specification of parameters for the structures of the installed apparatus necessary for acceptance of the equipment:

1. Undoped GaN layer: layer thickness at the discretion of the supplier, the level of unintentional n-type subsidy of less than $1 \times 10^{17} \text{ cm}^{-3}$, electron mobility higher than 350 cm²/Vs, thickness uniformity better than 2%.
2. A layer of n-type GaN doped Si layer thickness at the discretion of the supplier, the level of n-type subsidies greater than $5 \times 10^{18} \text{ cm}^{-3}$, electron mobility higher than 300 cm²/Vs
3. A layer of p-type GaN doped Mg: thickness at the discretion of the supplier, the level of n-type subsidies greater than $2 \times 10^{17} \text{ cm}^{-3}$, electron mobility greater than 10 cm²/Vs.
4. Undoped AlGaIn layer, the layer thickness at the discretion of the supplier, the composition of $x = 0.20$, homogeneity of the composition over the surface of the sample more than 1%
5. The structure of InGaIn / GaN multiple quantum well, data structure (composition and thickness of layers and the number of quantum wells) as appropriate, the emission wavelength longer than 410 nm wavelength uniformity over the surface of the sample at 3 nm.

Parameters structures will be verified on the whole surface of the sample with the exception of 3 mm from the edge of the sample.



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Annex No. 5a-2 – Technical specification table: „MOVPE Apparatus“

The subject matter of the public contract is equipment based on technology allowing organo-metallic epitaxy and preparation of nitride nano-hetero-structures which, in accordance with Section 46(4) the Act includes following parts and complies with technical conditions:

Description and minim specification of the Apparatus as defined by the Client	Description and specification of the Apparatus offered by the Contractor	Complies YES/NO
MOVPE APPARATUS		
Apparatus must enable growth of high quality nitride semiconductors with broad band gap energy with the epitaxy growth temperature up to 1200 °C.		
Small size stainless steel vertical reactor construction designed for research and development application is required to decrease the energy and material consumption (working gas mixture flow rate through the reactor around 20slpm or less).		
The apparatus has to enable epitaxy under a low or atmospheric pressure. Dry pump with flow rate at least 120 m ³ per hour is required for reactor pumping, the reactor pressure has to be controlled in the range 0.05 – 1 bar. The system has to keep the same pressure between Run and Vent lines of metalorganics to avoid pressure instability with Vent/Run switching of metalorganics.		
The introduction of carrier gas and precursor mixture into the reactor must have vertical alignment with homogeneous precursor concentration and flow over whole susceptor area.		
The distance of metal-organic entrance and the substrate has to be adjustable and computer controlled during the epitaxial process.		
Precursors of the group III and group V elements have to enter the reactor separately.		
The reactor walls and the mixing manifold have to be cooled.		
The stainless steel gas piping with VCR connections are required. All piping, VCR and valves must have polished inner surface to minimize an adsorption of substances on the inner piping surface.		
Apparatus has to be equipped at least by		



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<p>5 branches for metal-organic precursors (TMGa, TMI_n, TMAI, DMHz, Cp₂Mg), and has to have preparation for at least 2 spare metal-organic lines. The lines for TMAI, TMI_n and for Cp₂Mg has to enable heating up to 60 °C to ensure sufficient concentration of metalorganics in the carrier gas. The carrier gas for each bubbler has to be switchable between N₂ or H₂. The metalorganic lines have to be equipped by the blinded connection for He leak detector.</p>		
<p>The TMI_n line has to be equipped by the component measuring concentration of TMI_n in line and controlling the flow rate through the MFC (closed loop).</p>		
<p>Apparatus must contain lines for at least 4 gas sources (NH₃, N₂, H₂ and SiH₄) and a preparation for one spared gas line. The SiH₄ has to be built as dilution line for layer doping.</p>		
<p>The apparatus must be equipped by the moisture sensor with sensitivity at least 1 ppb</p>		
<p>One line purely for carrier gas with controlled flow rate is required for balancing the flow rate through the reactor</p>		
<p>The system should be equipped by at least 3 thermostatic water cooled baths for metal-organic cooling.</p>		
<p>Rotary SiC coated graphite susceptor with resistive or radiofrequency heating is required for achieving high thickness and compositional homogeneity of the epitaxial layers.</p>		
<p>Whole epitaxial process together with valves, mass flow and pressure controllers have to be computer controlled to achieve sufficient accuracy for nanoheterostructure preparation.</p>		
<p>The system has to enable equipment by in situ monitoring of epitaxial process by measuring real temperature and the curvature of sample during the epitaxial process. Three optical ports are necessary for this monitoring.</p>		
<p>The system has to be installed in the laboratory with size 510 x 410 x 300 cm (length x width x height). The size of the apparatus must not exceed the size 420 x 200 x 250 cm (length x width x</p>		



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height) to provide reasonable passage for the operational staff around the apparatus for safety reason and to provide sufficient space for necessary additional equipment in the laboratory (control computer, scrubber, gas purifiers, ammonia detection, necessary gas supply and extraction air tubing		
The maximal load of the laboratory floor is 4.1 kN/m ³ . Any component of the apparatus must not exceed this value		
The apparatus has to be delivered in parts (modules) in such a way that none of the part is exceeding the size 180 x 130 x 230 cm (length x width x height) due to the limited space for transportation of the apparatus in the building to the laboratory room		
The apparatus has to be installed in a cabinet system with extraction air possibility for safety reason		

Bidders shall provide in their bid an unambiguous statement to all the above points of the technical specification, which will clearly indicate whether the offered Apparatus complies (or exceeds) the required parameters, or in which manner the offered Apparatus ensures the required functionality.