ADDITIONAL INFORMATION ON THE TENDER CONDITION Nr. 5

Contracting Authority:	Fyzikální ústav AV ČR, v. v. i.
Seat:	Na Slovance 1999/2, 182 21 Praha 8
Identification No.:	68378271
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
Annex 5a-2/2 of Tender Documentation

According a typical understanding within the MOCVD reactor technology: Typical working gas mixture flow rate i.e. process gases through the reactor is around 20slpm or less, however the total flow through the reactor including purge gases may be higher.

Answer:
The Contracting Authority amends the wording of Annex 5a-2/2:

„Small size stainless steel vertical reactor construction designed for research and development application is required to decrease the energy and material consumption (typical working gas mixture flow rate i.e. process gases through the reactor around 20slpm or less). The total flow through the reactor including purge gases may be higher."

Question 2
Annex 5a-2/9 of Tender Documentation

Using of DMHy (DMHz is a typing error in your tender) is not necessary, but increase drastically the necessary safety features in our apparatus, but also in your laboratory and therefore the costs.

Answer:
After consideration of safety expenses the Contracting Authority adds an option to replace the metal-organic precursor DMHy by the precursor TEGa. The text of Annex 5a-2/9 is changed to:

„Apparatus has to be equipped at least by 5 branches for metal-organic precursors (TMGa, TMIn, TMAl, DMHy or TEGa, Cp2Mg), and has to have preparation for at least 2 spare metal-organic lines. The lines for TMAl, TMIn 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."

Question 3
Annex 5a-2/21 of Tender Documentation

We double checked your request and can´t participate to the tender with your request. 220 x 140 x 230 cm (length x width x height) is the limiting size for transportation parts in our case.

Answer:
The Contracting Authority can increase slightly the space for transportation through the corridor by temporary building adaptation. The text of Annex 5a-2/21 is changed to:

„The apparatus has to be delivered in parts (modules) in such a way that none of the part is exceeding the size 220 x 140 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."

Question 4:
Your requirement "comply with all technical safety standard valid in the Czech Republic". We cannot justify whether we meet these requirement. It is quite sure that our equipment meets common standards as listed in our EC certificate which we will submit in the tender. It is common that it is in the responsibility of the end user to check whether these standards are in line with local regulations, and to obtain a permission of MOCVD operation in your country. But since Czech Republic is belonging of the EU , it should be fine.

Answer:
The Contracting Authority agrees.

Question 5
In one of the document it is mentioned , that the dead line of the final ATP i.e. showing the process specification is June 30th, 2015. But please understand that this date is strongly related to the beginning of the project i.e. the Purchase Order (P.O.) , the official start of the project i.e. having first payment, having the Design Review Meeting (DRM) ,etc. Further it related to your preparation of the laboratory i.e. gases, water, power , etc. must be available. So, we ask you to consider that there is a possibility to elongate the project like until mid of September 2015, just in case. But be assured that we try our best to fit into your existing time line, in case all the above conditions are fulfilled.

Answer:
There is a possibility to extend the project duration up to 15th of September 2015 in case of unexpected problems during the project realization.

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. 4 of July 3 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. There is a possibility to extend the project duration up to 15th of September 2015 in case of unexpected problems during the project realization.

In Prague

Mgr. Václav Kafka

Digitálně podepsal Mgr. Václav Kafka
DN: c=CZ, o=Fyzikální ústav AV ČR, v.v.i. [IČ 68378271], ou=2041222, cn=Mgr. Václav Kafka, serialNumber=P429891
Datum: 2014.08.14 17:00:03 +02'00'

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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

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 ^{o}C.
- Small size stainless steel vertical reactor construction designed for research and development application is required to decrease the energy and material consumption (typical working gas mixture flow rate i.e. process gases through the reactor around 20slpm or less). The total flow through the reactor including purge gases may be higher.
- The apparatus has to enable epitaxy under a low or atmospheric pressure. Dry pump with flow rate 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. 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 of different nitride compounds (AlGaN, GaN or InGaN) in one heterostructure.
- 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, TMIn, TMAl, DMHy or TEGa, Cp_2Mg), and has to have preparation for at least 2 spare metal-organic lines. The lines for TMAl, TMIn and for Cp_2Mg 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 N_2 or H_2. The metalorganic lines have to be equipped by the blinded connection for He leak detector.
- The TMIn line has to be equipped by the component measuring concentration of TMIn in line and controlling the flow rate through the MFC (closed loop).
- Apparatus must contain lines for at least 4 gas sources (NH_3, N_2, H_2 and SiH_4) and a

preparation for one spared gas line. The SiH_4 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.
- The system must 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 has 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/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 220 x 140 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 1×10^{17} cm^{-3}, electron mobility higher than 350 cm^2/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 5×10^{18} cm^{-3}, electron mobility higher than 300 cm^2/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 2×10^{17} cm^{-3}, electron mobility greater than 10 cm^2/Vs.
4. Undoped AlGaN 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 InGaN / 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.

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 ^{o}C.		
Small size stainless steel vertical reactor construction designed for research and development application is required to decrease the energy and material consumption (typical working gas mixture flow rate i.e. process gases through the reactor around 20slpm or less). The total flow through the reactor including purge gases may be higher.		
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 according to the required growth parameters of different nitride compounds (AlGaN, GaN or InGaN) in one heterostructure.		
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.		

Apparatus has to be equipped at least by 5 branches for metal-organic precursors (TMGa, TMIn, TMAl, DMHz or TEGa, Cp_2Mg), and has to have preparation for at least 2 spare metal-organic lines. The lines for TMAl, TMIn and for Cp_2Mg 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 N_2 or H_2. The metalorganic lines have to be equipped by the blinded connection for He leak detector.		
The TMIn line has to be equipped by the component measuring concentration of TMIn in line and controlling the flow rate through the MFC (closed loop).		
Apparatus must contain lines for at least 4 gas sources (NH_3, N_2, H_2 and SiH_4) and a preparation for one spared gas line. The SiH_4 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		
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 has 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 real temperature and the 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 size of the apparatus must not exceed the size 420 x 200 x 250 cm (length x width x height)		
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 220 x 140 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.