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**Datasheet for the decision
of 4 March 2021**

Case Number: T 2037/14 - 3.4.01

Application Number: 09790533.5

Publication Number: 2430637

IPC: G21G4/08, H01J27/18, H01J37/08,
H05H1/18

Language of the proceedings: EN

Title of invention:

ECR PARTICLE BEAM SOURCE APPARATUS, SYSTEM AND METHOD

Applicant:

Alpha Source, Inc.

Headword:

Alpha Source / Particle Beam source

Relevant legal provisions:

RPBA Art. 13
EPC Art. 83
RPBA 2020 Art. 25

Keyword:

Late-filed request - amendments after arrangement of oral proceedings
Sufficiency of disclosure - undue burden (yes)



Beschwerdekammern

Boards of Appeal

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Case Number: T 2037/14 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 4 March 2021

Appellant:
(Applicant)

Alpha Source, Inc.
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Representative:

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Decision under appeal:

**Decision of the Examining Division of the
European Patent Office posted on 5 May 2014
refusing European patent application No.
09790533.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair

P. Scriven

Members:

P. Fontenay

R. Winkelhofer

Summary of Facts and Submissions

- I. The appeal was filed by the applicant/appellant against the Examining Division's decision to refuse European patent application 09 790 533.

- II. The application was refused because the main and auxiliary requests did not comply with the requirements of Articles 83 and 84 EPC. The main request was also considered to contain added subject-matter, contrary to Article 123(2) EPC.

- III. With regard to sufficiency of disclosure (Article 83 EPC), the Examining Division held that the skilled person did not find, in the application, the required information for making an ion source capable of generating an ion beam in which "at least 50% of the ions in the beam are multiply ionized ions in the selected final ionization state" (claims 1 and 9 of the main request) or an ion source such that "during operation, the ion source generates an ion beam having a current of 20 mA or greater" (claims 1 and 9 of the auxiliary request).

- IV. The features objected to under Article 83 EPC were also considered unallowable under Article 84 EPC, since they merely defined results to be achieved.

- V. With the statement setting out the grounds of appeal, the appellant requested that the appealed decision be

set aside and that a patent be granted on the basis of the main or auxiliary requests underlying the impugned decision.

- VI. In a communication of the Board pursuant to Article 15 RPBA 2007, the appellant was informed of the Board's provisional opinion.
- VII. While the Board did not share the Examining Division's view with regard to the objection of added subject-matter, it endorsed their position regarding lack of clarity of the claimed subject-matter and lack of a sufficient disclosure in the application allowing the skilled person to carry out the claimed inventions.
- VIII. With regard to the issue of sufficiency of disclosure concerning the main request, the Board referred to statements in the description according to which the ratio of He^+ to He^{++} ions in the confinement chamber depended on a complicated set of relations between gas density, ECR power, source geometry and magnetic field geometry. The problems faced by the skilled person were made worse by the claim's wording which was limited neither in the kind of gas present in the confinement chamber nor by the final ionisation state considered.
- IX. Similar comments were made with regard to independent claims 1 and 9 of the auxiliary request. The Board emphasised that the determination of appropriate operating conditions and the selection of parameter ranges were not straightforward because of the interdependence of the effects of the various relevant

parameters.

- X. In response to the Board's communication, the appellant filed new main and auxiliary requests, replacing the previous requests on file, together with a supporting document entitled "Further Supporting Evidence" showing experimental results. The appellant submitted that the amended requests addressed the issue, raised by the Board in its previous communication, regarding the gas in the confinement chamber and the selected final ionization state. Concretely, the independent claims of both requests were limited to the preferred embodiment with helium gas and a selected final ionization state corresponding to He^{++} ions.
- XI. At oral proceedings before the Board, the appellant further elaborated on the question of sufficiency, stressing that the application contained sufficient information. In particular, the skilled person was highly-qualified and an expert in the field of plasma physics. While acknowledging that multiple parameters were involved in the composition of the ion beam produced by the system and method of the invention, the relations between the various parameters involved were not mysterious or difficult for experts such as the skilled person. The further evidence produced with the response to the Board's communication had been prepared in view of the oral proceedings. It was, however, not meant to complete the teaching of the description, but only to emphasize how mere experimentation allowed optimisation of the system and method, thus arriving at 50% of the ions being He^{++} ions (main request) or to a current of 20mA (auxiliary request).

XII. Claim 1 of the main request reads:

*An ion source comprising:
a chamber disposed about a longitudinal axis and containing helium, He, gas;
a magnetic confinement system configured to produce a magnetic field in a confinement region within the chamber, wherein the confinement region is disposed about the axis and extends along the axis from a proximal end to a distal end, and wherein the magnetic field comprises:*

a first magnetic mirror located at the proximal end of the confinement region;

a second magnetic mirror located at the distal end of the confinement region;

a substantially uniform magnetic field disposed about and directed substantially parallel to the longitudinal axis, the substantially uniform magnetic field being located between the first and second magnetic mirrors; and

an electron cyclotron resonance driver which produces a time varying electric field which drives the cyclotron motion of electrons located within the confinement region, said driven electrons interacting with the He gas to form a confined plasma; wherein, during operation, the magnetic confinement system confines the plasma in the confinement region such that a portion of He atoms in the plasma experience multiple ionizing interactions with the driven electrons to form multiply ionized He ions having a selected final ionization state of He⁺⁺;

wherein, during operation, the second magnetic mirror is configured to leak He ions to generate an ion beam wherein at least 50% of the He ions in the beam are multiply ionized He ions in the selected final ionization state of He⁺⁺ upon exiting the confinement region through the second magnetic mirror.

XIII. Claim 1 of the auxiliary request reads identically, except in the final integers defining behaviour during operation:

*...
wherein, during operation, the ion source is configured to generate an ion beam having a current of 20 mA or greater.*

Reasons for the Decision

Admission/consideration of the new main and auxiliary requests

1. The Board's summons to oral proceedings was issued on 9 December 2019 and is deemed notified ten days later (Rule 126(2) EPC). This was before the entry into force of the new Rules of Procedure of the Boards of Appeal (RPBA 2020) on 1 January 2020.
2. The new main and auxiliary requests were filed in response to the Board's provisional opinion under Article 15(1) RPBA 2007 that had been issued together

with the summons.

3. Under Article 25 RPBA 2020, Article 13(3) RPBA 2007 applies.
4. The amendments to the independent claims of both requests are straightforward in that they just limit the scope of the claims to the preferred embodiment of the invention according to which the gas used is Helium and the final ionisation state refers to He⁺⁺ ions. Moreover, the amendments address an essential aspect of the objection raised by the Board under Article 83 EPC in its provisional opinion, namely, that the claims was limited neither in the kind of gas present in the confinement chamber, nor in the selected final ionization state.
5. Hence, the Board considered (admitted) both requests.

Main request - Sufficiency of disclosure

6. The feature in claim 1 according to which "during operation, the second magnetic mirror is configured to leak He ions to generate an ion beam wherein at least 50% of the He ions in the beam are multiply ionized He ions in the selected final ionization state of He⁺⁺ upon exiting the confinement region through the second magnetic mirror", is not an effect brought about just by the the recited structural elements. It is, rather, a further functional limitation. This is the general teaching of the application and is acknowledged in the appellant's submissions. This effect is to be achieved by appropriate settings for the various parameters contributing to the production of He⁺⁺ particles.

7. Electron Cyclotron Resonance (ECR) plasma sources generate energetic electrons by exciting their cyclotron motion of the electrons within a magnetic field. The ECR plasma confines gas at low pressure in a vacuum chamber, so that free electrons, excited into cyclotron motion by an oscillating electric field, have time to acquire sufficient energy to ionise atoms of the gas (page 1, lines 9 - page 2, line 1, of the published application).
8. During operation, the system of the invention confines the plasma in the confinement region such that a portion of atoms in the plasma experiences multiple ionising interactions with the driven electrons, and form multiply-ionised Helium ions, He^{++} (cf. page 3, lines 5-12).
9. As underlined by the appellant, the skilled person is a highly-skilled physicist, well experienced in the field of plasma physics and well aware of the mechanisms contributing to the production of ions.
10. It is not disputed that the operation of the ion source is determined by complex relations between multiple parameters. The number of parameters involved, combined with the fact that their effects mutually interfere makes it particularly difficult to assess which combinations of parameters might actually provide the defined result. The passage on page 25, lines 23-25, of the application, quite rightly, acknowledged that the ratio of He^+ to He^{++} depends on a complicated set of relations between gas density, ECR power, source geometry, and magnetic field geometry.
11. As underlined throughout the application, and by the appellant with reference to the document entitled

"Further Supporting Evidence", experimentation would allow a certain degree of optimization when starting from a given process.

12. The appellant's arguments have not persuaded the Board that there is sufficient disclosure.
13. A prerequisite for the skilled person to arrive at the claimed invention by way of experimentation is the determination of a concrete arrangement on the basis of which further experimentation might reasonably be expected to produce the desired result.
14. The application does not provide the guidance required for this preliminary determination. While the references, throughout the description, to the general principles to be applied in carrying out the invention are useful when it comes to the experimentation phase and would guide the skilled person in identifying which parameters are to be modified and optimised, they are not sufficient for defining the basic features of the system and method that will, in the end, lead to a successful implementation.
15. With regard, more specifically, to the parameters referred to in the passage of page 25, it has to be noted that the skilled person is given no information on the source geometry that could somehow look promising in view of the intended effect. Similarly, the application contains insufficient detail as to the field geometry that should be implemented and as to how it should be adapted to the selected source geometry. The appellant's "Further Supporting Evidence" confirms the difficulty faced by the skilled person in identifying the adequate field geometry, when it acknowledges that increasing the mirror ratio will

increase the plasma density and the fraction of He^{++} , but also warns that "Sufficiently high mirror ratios can cause instabilities in the plasma and should be avoided."

16. In the absence of such guidance in the patent application, the skilled person has no other choice than to start from arbitrary ECR ion sources and to experiment without any guarantee that the selected configuration is indeed suitable, and to repeat the process with various other sources and operating parameters. The amount of experimentation required thus extends far beyond what may be expected from the skilled person entrusted with implementing the claimed invention. All in all, the amount of time and experimentation required to arrive at the claimed invention qualifies as an undue burden.

17. It follows that the claimed ion source is not disclosed in a manner sufficiently clear and complete to be carried out by the skilled person, contrary to Article 83 EPC. The same applies to the method of generating an ion beam according to independent claim 9.

Auxiliary request - Sufficiency of disclosure

18. Claim 1 of auxiliary request 1 differs from claim 1 of the main request, in essence, in that the feature regarding the ratio of ratio of He^+ to He^{++} ions has been deleted, and in that the feature regarding the ion source being configured to generate an ion beam with a current of at least 20 mA has been introduced. Corresponding amendments were made in independent claim 9. New auxiliary request corresponds to previous

auxiliary request limited to the preferred embodiment with helium gas.

19. The generation of a current of 20 mA or greater is a functional limitation on the claimed system, that is achieved by appropriate selection of the operating parameters.
20. The current to be generated is the result of He^{++} and He^+ ions leaving the confinement chamber at the distal end of the confinement region. The effect is the result of a multiplicity of mechanisms taking place in the confinement region, where the intensity of the ionisation process is determined by a multiplicity of parameters including, among other thing, the pressure of helium gas in the chamber, the geometry of the chamber, and the geometry of the magnetic field. Interfering phenomena such as recombination, charge exchange, and radial diffusion also affect the composition of the plasma and consequently that of the beam leaving the confinement region and thus the current it generates.
21. The issues faced by the skilled person in carrying out the claimed invention are, essentially, the same as those addressed above with regard to the main request. While the proportion of the two ions species is not specified, which possibly leaves more freedom for the skilled person, the process must nevertheless be controlled so that the current resulting from the two ions be at least 20mA. Whether the effect is to be achieved by privileging the production of one ionisation state over the other is not specified. This aspect appears relevant, however, since the charge carried by one He^+ is only half that carried by an alpha particle. Privileging He^{++} particles would

require the skilled person to select parameters which contribute to increasing the confinement time of He⁺ in the confinement chamber, while this would be less relevant if the current is to rely on movement of He⁺ particles.

22. In the absence of clear indications in the application, the skilled person is not even in a position to select a promising approach.
23. As a consequence, the auxiliary request also fails due to insufficient disclosure (Article 83 EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chair:



D. Meyfarth

P. Scriven

Decision electronically authenticated