Internal distribution code:

(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 11 May 2022

Case Number: T 0978/19 - 3.4.02

Application Number: 06811703.5

Publication Number: 1978348

IPC: G01Q60/32, G01Q10/06, B82Y35/00

Language of the proceedings: EN

Title of invention:
SCANNING PROBE MICROSCOPE

Applicant:
National University Corporation Kanazawa University

Headword:

Relevant legal provisions:
EPC 1973 Art. 54(1), 111(1) sentence 2
EPC Art. 123(2)
RPBA 2020 Art. 11

Keyword:
Novelty - (no) - second auxiliary request (yes)
Remittal - special reasons for remittal - (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0978/19 - 3.4.02

D E C I S I O N
of Technical Board of Appeal 3.4.02
of 11 May 2022

Appellant: (Applicant)	National University Corporation Kanazawa University Nu 7, Kakuma-machi Kanazawa-shi, Ishikawa 920-1164 (JP)
Representative:	Margotti, Herwig Franz Schwarz & Partner Patentanwälte Wipplingerstrasse 30 1010 Wien (AT)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 16 November 2018 refusing European patent application No. 06811703.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	B. Müller
Members:	H. von Gronau
	F. J. Narganes-Quijano

Summary of Facts and Submissions

I. The applicant's appeal is directed against the decision of the examining division to refuse European patent application No. 06811703.5. The examining division refused the application on the grounds that the subject-matter of independent claim 1 of the main request and of the first, second, and fourth to sixth auxiliary requests was not new in view of document

D1: SCHIENER JENS ET AL: "Stabilized atomic force microscopy imaging in liquids using second harmonic of cantilever motion for setpoint control", REVIEW OF SCIENTIFIC INSTRUMENTS, AIP, MELVILLE, NY, US, vol. 75, no. 8, 26 July 2004 (2004-07-26), pages 2564-2568,

and the subject-matter of claim 1 of the third and seventh auxiliary requests did not involve an inventive step starting from document D1 in combination with the common general knowledge of the person skilled in the art.

The decision under appeal also included an observation by the examining division to the effect that the expression "twice or more" in claim 1 of the main and the first to third auxiliary requests, in claim 7 of the main and first auxiliary requests, and in claim 6 of the second and third auxiliary requests was contrary to the requirements of Article 123(2) EPC.

II. The examining division further cited the following document:

D2: WO 2005/104137 A1

III. With the statement of grounds of appeal the appellant requested that the decision under appeal be set aside, and a patent be granted based on the claims of a main request or of first to seventh auxiliary requests filed with the statement setting out the grounds of appeal. Independent claim 1 of the main request and of the first to third auxiliary requests corresponded to claim 1 of the respective requests underlying the decision under appeal.

IV. As a precaution the appellant requested that oral proceedings be held.

V. In a communication annexed to a summons to oral proceedings the board expressed its provisional opinion that, inter alia, the subject-matter of claim 1 of the main request and that of the first, second and fourth to sixth auxiliary requests was not new in view of document D1 and that the subject-matter of claim 1 of the third and seventh auxiliary requests did not involve an inventive step when starting with document D1 as closest prior art document.

VI. With a letter dated 8 April 2022 the appellant withdrew its request for oral proceedings and requested that the proceedings be continued in writing. It also filed arguments in support of its requests.

VII. Subsequently the oral proceedings were cancelled.

VIII. Claim 1 of the main request reads as follows:

"A cantilever excitation device for exciting a cantilever (5), which is used in a scanning probe microscope (1) for oscillating the cantilever (5) and performing relative scanning between the cantilever and

a sample and the microscope comprising the cantilever and a sensor for detecting displacement of the cantilever, the device comprising:
an integral-multiple amplitude detection section (31) for detecting an integral-multiple component amplitude that is amplitude of a component of frequency as an integral multiple of twice or more the excitation frequency of the cantilever (5) from the displacement signal detected by the sensor,
characterized in that the device further comprises:
an excitation source of the cantilever,
an excitation intensity adjustment section (33) for adjusting excitation intensity of the excitation source (23) of the cantilever (5) based on the detected integral-multiple component amplitude."

Claim 1 of the first auxiliary request differs from claim 1 of the main request in that the last paragraph of the claim is replaced by the following paragraph:

"an excitation intensity adjustment section (33) for adjusting excitation intensity of the excitation source (23) of the cantilever (5) based on the difference between the detected integral-multiple component amplitude and a corresponding target value of the integral-multiple component."

Claim 1 of the second auxiliary request differs from claim 1 of the main request in that at the end following passage was added:

", wherein the excitation intensity adjustment section includes a slow control section for adjusting the excitation intensity with a speed corresponding to time for acquiring at least one frame image by scan of the cantilever."

Reasons for the Decision

1. The appeal is admissible.

2. Main request - claim 1 - novelty (Article 54(1) EPC 1973)

2.1 The examining division was of the opinion that the subject-matter of claim 1 was not new in view of document D1 (see reasons for the decision, 5.1).

2.2 The appellant was of the opinion that D1 did not disclose that the modified amplitude setpoint voltage influenced the excitation source of the cantilever but modified the amplitude of the oscillation of the cantilever by changing the height of the sample, i.e., the distance between the AFM (atomic force microscope) and the probe. Therefore, D1 did not disclose a method of keeping the free vibration amplitude itself stable (see grounds of appeal, corresponding passages on pages 7 to 13). A change in the drive amplitude of optimal AFM imaging as a supposed alternative to changing the setpoint (see D1, page 2566, left hand column, penultimate paragraph) could not be regarded as "*adjusting excitation intensity of the excitation source (23) of the cantilever (5) based on the detected integral-multiple component amplitude*" as required by claim 1. In the paragraph of D1 cited in brackets above, the drive amplitude was only mentioned to clarify that the setpoint (height of the sample) was indeed varied by changing the drive amplitude. Document D1 did not disclose that the excitation intensity of the excitation source was changed, or that such a change could be identified with changing the "drive

amplitude". Further, the "piezo drive control" could also be used to modify the height of the sample rather than the oscillation of the cantilever. Moreover, on page 2567, right hand column, first paragraph, document D1 explained that when the sample had areas with very soft material, "the setpoint control [according to D1] will not find a stable operating point, and would eventually decrease the setpoint value to zero. To avoid that the tip is forced into continuous contact with the sample by such a controller reaction, the range of the setpoint modification is limited to 20% of the absolute setpoint value". If according to D1 the oscillation amplitude of the cantilever were adjusted, this could not happen, since the tip would, even when operated at high amplitudes, always only intermittently contact the sample. Furthermore, D1 proposed in the same column, third paragraph, an atomic force microscope with a height regulation using the second harmonic (letter dated 8 April 2022, page 2, second and third paragraphs).

2.3 The board is of the opinion that document D1 discloses a cantilever excitation device for exciting a cantilever, which is used in a scanning probe microscope for oscillating the cantilever and performing relative scanning between the cantilever and a sample and the microscope comprising the cantilever and a sensor for detecting displacement of the cantilever (implicit features of an atomic force microscope (AFM)), the device comprising:

an integral-multiple amplitude detection section (see Figure 1, "Lock-in 2nd harmonic") for detecting an integral-multiple component amplitude that is the amplitude of a component of frequency as an integral multiple of twice or more the excitation frequency of

the cantilever from the displacement signal detected by the sensor (see page 2564, right hand column, last paragraph, first sentence; page 2565, left hand column, penultimate paragraph, second and third sentences; Figure 1)
the device further comprising:
an excitation source of the cantilever (the cantilever is excited to oscillate, see Figure 1 and page 2565, left hand column, penultimate paragraph, "*excitation signal*" for the cantilever),
an excitation intensity adjustment section (see Figure 1) for adjusting excitation intensity of the excitation source of the cantilever (see page 2564, right-hand column, second paragraph, "*The variations in free oscillation have to be compensated by changing the excitation amplitude or the absolute setpoint to stay in the parameter range of gentle imaging.*") based on the detected integral-multiple component amplitude (see page 2564, right-hand column, third paragraph: "*the setpoint correction has to be automated*"; see also the same column, fourth paragraph: "*In this article we show that the second harmonic of the cantilever oscillation can be used as the signal indicating drift for realization of an automated setpoint control.*").

The appellant essentially disputed that D1 disclosed an excitation intensity adjustment section for adjusting excitation intensity of the excitation source of the cantilever based on the detected integral-multiple component amplitude. However, it is clear from the disclosure of document D1 that the oscillation of the cantilever in tapping mode is kept at an absolute value, denoted in D1 as "amplitude setpoint", on the one hand in the usual manner by the z-feedback of the AFM via height adjustment of the sample (see page 2564, left-hand column, last two sentences), and on the other

hand, as suggested by the authors of D1, by changing the excitation amplitude to compensate for variations of the free oscillation and stay in the parameter range of gentle imaging (see page 2564, right-hand column, second paragraph) based on the second harmonic of the cantilever oscillation (see page 2564, right-hand column, last paragraph: "*In this article we show that the second harmonic of the cantilever oscillation can be used as the signal indicating drift for realization of an automated setpoint control.*").

From the above it is apparent that these two setpoints are not the same and serve different purposes. The "amplitude setpoint" is set to image the surface of the sample, and the "excitation amplitude or the absolute setpoint" determines the excitation intensity. The setpoint control in document D1 has therefore the purpose of adjusting the excitation amplitude or the absolute setpoint. D1 even explains that the second harmonic is less suitable for being used for height adaptation: "*In practice, the signal of the second harmonic is usually too noisy for direct use for z-feedback if the force interaction should be kept low.*" (see section "IV. Discussion", penultimate paragraph). The board does not share the appellant's view that the "setpoint" in document D1 could indicate the "height of the sample". Throughout the document the expression "setpoint" is used in relation to the amplitude of the cantilever oscillation or the excitation amplitude. According to document D1 the amplitude setpoint is influenced on the one hand by the z-feedback via height adjustment and on the other hand by the modified amplitude setpoint voltage of the automated setpoint control. Document D1 emphasises that there are two separate control systems (setpoint control and z-feedback control) that should not

interfere (see D1, page 2567, left hand column, third paragraph: "*Using our method, the average value of the amplitude of the second harmonic is kept at the preset value. The average is defined over a time given by the time constant of the complete setpoint control loop including the PI controller. This constant has to be chosen shorter than the time constant of the drift to be compensated. However, the effective time constant of the z feedback of the AFM limits this choice. To avoid an interference of the two control actions, the setpoint control should be considerably slower than the z-feedback control*"). With respect to the first paragraph in the right-hand column on page 2567 referred to by the appellant it is to be understood that in the case addressed the setpoint control (not the z-feedback control) would decrease the setpoint value (i.e. output voltage of the setpoint control) to zero. The sentence "*To avoid that the tip is forced into continuous contact with the sample by such a controller reaction, the range of the setpoint modification is limited to 20% of the absolute setpoint value*" addresses a negative consequence of an amplitude setpoint voltage being zero resulting in the cantilever tip being in permanent contact with the sample and not oscillating. The use of the second harmonic for height regulation subsequently addressed in the third paragraph on the right-hand column of page 2567 is the inverse of the actual setup previously presented in document D1 and does not change that teaching.

2.4 The board therefore comes to the conclusion that the setpoint control of document D1 controls the excitation amplitude of the cantilever and that all features of claim 1 are known from document D1. The subject-matter of claim 1 of the main request is therefore not new in view of document D1 (Article 54(1) EPC 1973).

3. First auxiliary request - claim 1 - novelty (Article 54(1) EPC 1973)

3.1 In addition to claim 1 of the main request, claim 1 of the first auxiliary request defines that excitation intensity of the excitation source (23) of the cantilever (5) is based on the difference between the detected integral-multiple component amplitude and a corresponding target value of the integral-multiple component.

3.2 The examining division was of the opinion that the additional feature of claim 1 was also known from D1 (see reasons for the decision, section 6).

3.3 The appellant was of the opinion that, with the additional features of claim 1, the detected value was advantageously controlled to coincide with the target value (see grounds of appeal, page 14, first and second paragraph). With a letter dated 8 April 2022 the appellant put forward that document D1 disclosed an "automated setpoint control", but that this control only changed the amplitude of the cantilever based on the difference between the detected integral-multiple component amplitude and a corresponding target value of the integral-multiple component by raising and lowering the sample, and not by adjusting the excitation intensity itself. D1 also stated that all images provided in D1 were acquired at the optimal setpoint being controlled automatically.

3.4 The board agrees with the examining division and considers that the subject-matter of claim 1 is not new. D1 also discloses the additional feature referred

to in point 3.1 above. In Figure 1 the inputs of the PI controller are the detected value of the second harmonic and a settable target value for the second harmonic amplitude, in order to keep the amplitude of the second harmonic at the pre-set values (see D1 section II.A, end of penultimate paragraph). The PI controller in D1 consists of a proportional plus integral controller, i.e. the excitation adjustment device includes a proportional controller (see section II.A; the proportional controller performs a difference between the input second harmonic amplitude and the setpoint for the second harmonic amplitude). That means that the PI controller in document D1 adjusts the excitation intensity based on the difference between the detected integral-multiple component amplitude and a corresponding target value of the integral multiple component.

3.5 The subject-matter of claim 1 of the first auxiliary request is therefore not new in view of document D1 (Article 54(1) EPC 1973).

4. Second auxiliary request - claim 1 - novelty (Article 54(1) EPC 1973)

4.1 The examining division was of the opinion that the subject-matter of claim 1 was not new (see reasons for the decision, section 7).

4.2 The appellant was of the opinion that the subject-matter of claim 1 advantageously prevented the influence of variation in the cantilever oscillating amplitude due to the irregularity of the sample, and thus, the image quality was improved (see grounds of appeal, page 14, fourth and fifth paragraph). D1 disclosed a "slow integrator gain of the PI

controller", without defining a relation to the time for acquiring at least one frame image. Only a time constant of 0.2 s was mentioned in document D1. According to the opinion of the examining division, this time constant corresponded to a standard time for acquiring a frame image in biological applications when fast imaging was required. As evidence of this standard time, paragraph [0054] of the description of the present application was cited, wherein an imaging speed of 200 msec/frame in the measurement of a biological sample was disclosed, meaning that a frame was acquired in 0.2 s. In this respect the examining division relied on a passage in the specification of the present application itself to interpret the prior art, and how the device and/or method disclosed in D1 worked. The examining division therefore applied the teaching of the present application, and how a specific embodiment functions, to the prior art of D1 in order to assess novelty of claim 1 of the second auxiliary request. This constituted an ex-post-facto analysis of the prior art in knowledge of the teaching of the present application. Nowhere in document D1 itself was it disclosed how long it took to acquire at least one frame image (see letter dated 8 April 2022, page 2, last paragraph to page 3, third paragraph).

4.3 The board shares the opinion of the examining division that document D1 discloses a PI controller as an excitation adjustment device which consists of a proportional plus integral controller, i.e. the excitation adjustment device includes an integral controller. Said integral controller can be seen as the slow control section. This interpretation is also supported by page 2565, right hand column, first paragraph of D1: "*We typically use a slow integrator gain of the PI controller (resulting time constant ~0.2*

s) and no proportional gain.". In this passage the time constant of 0.2 s of the integrator is mentioned. However, the board does not share the opinion of the examining division that the standard time for acquiring a frame image in biological applications disclosed in document D1 is 0.2 s/frame. As the appellant in its letter dated 8 April 2022 correctly pointed out, such a scanning speed is only disclosed in the present application in paragraph [0054] where it is not disclosed as the usual scanning speed but the scanning speed of the embodiment of Figure 4. Document D1, on the other hand, indicates the time constant of 0.2 s of the PI controller in relation to a line frequency of 1 Hz, and this feature does not imply a scanning speed of 0.2 s/frame.

4.4 The board therefore comes to the conclusion that the subject-matter of claim 1 of the second auxiliary request is new in view of document D1 (Article 54(1) EPC 1973).

4.5 Document D2 also does not disclose the subject-matter of claim 1. D2 discloses measuring the amplitude of at least one higher harmonic of the cantilever, but not the adjustment of the intensity of the excitation frequency at a rate corresponding to a time for the acquisition of at least one frame image by scan of the cantilever. Therefore, the board is satisfied that the subject-matter of claim 1 of the second auxiliary request is also new over document D2 (Article 54(1) EPC 1973).

5. Second auxiliary request - claim 1 - amendments (Article 123(2) EPC)

5.1 The examining division was of the opinion that the expression "twice or more" in the expression "twice or more the excitation frequency of the cantilever (5)" in claim 1 of, amongst others, the second auxiliary request had no basis in the application as originally filed (Article 123(2) EPC). According to Figure 3 in combination with paragraphs [0048] and [0049] of the description, only the second harmonic amplitude was taken into consideration (see section 14 of the reasons for the decision).

5.2 The appellant was of the opinion that paragraphs [0015], [0037], [0060], [0066] and Figure 2 of the originally translated application provided a sufficient basis for the assumption that an integral-multiple component amplitude for detecting the amplitude could be selected and that the second harmonic component was just an advantageous embodiment (see grounds of appeal, section "Regarding the term 'twice or more the excitation frequency' - Concerning Main Request and 1st to 3rd Auxiliary Requests" on pages 6 and 7).

5.3 The board shares the appellant's opinion. From the cited paragraphs it is evident that the second harmonic amplitude only represents a preferred embodiment and that other integral-multiple components such as the third or fourth harmonic component could also be used for detecting the amplitude (see e.g. paragraph [0066] of the originally filed application).

5.4 The board therefore comes to the conclusion that the subject-matter of the independent claims 1 and 7 meets the requirements of Article 123(2) EPC.

6. Remittal - Article 111(1), second sentence, EPC 1973

6.1 In the light of the above, the appeal is allowable within the meaning of Article 111(1), first sentence, EPC 1973.

6.2 The examining division did not examine whether the subject-matter of claim 1 of the second auxiliary request involved an inventive step in the event that - as found by the board in point 4 above - the subject-matter of the claim was new over document D1 by virtue of the last of the features defined in the claim. Therefore, the board cannot review a decision of the examining division in this respect.

6.3 According to Article 111(1), second sentence, EPC 1973, a Board may either exercise any power within the competence of the department of first instance or remit the case to that department for further prosecution. In the present case the board would have to examine for the first time during the appeal proceedings whether the subject-matter of claim 1 involves an inventive step. In addition, this examination would possibly require an additional search. The board considers that these circumstances constitute special reasons that justify remittal of the present case to the department of first instance in line with Article 11 RPBA 2020. The board therefore exercises its discretion under Article 111(1), second sentence, EPC 1973 in remitting the case for further prosecution.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division for further prosecution.

The Registrar: The Chairman:

H. Jenney B. Müller

Decision electronically authenticated