

Patent issues

1. In reaching our conclusion that there is no SLC we have on a number of occasions referred to patents, the effect of patents, and to patent disputes or litigation. For both Bio-Rad and Zeiss the acquisition by Zeiss of the laser scanning microscope business of Bio-Rad's cell science division will resolve the litigation referred to in paragraph 2.21 of our conclusions. We have considered the effects of patents as barriers to entry in relation to the supply of multiphoton microscope systems in paragraphs 5.52 et seq. We have also considered the effects of patents on the counterfactual in paragraphs 5.88 et seq. In the course of our inquiry we have come across numerous patents, and applications for patents, that are relevant to the manufacture and sale of microscopes by Zeiss, Bio-Rad, Leica and others. Not all these patents have proved to be of significance for the purposes of our inquiry. Many have not. In our view the important patents for our purposes are:
 - (a) United States Patent 5,034,613 (the Cornell US patent);
 - (b) European Patent 0500717 B2 (the Cornell European patent);
 - (c) United States Patent 5,777,732 (the Hanninen and Hell US patent);
 - (d) German Patent 44 14 940 C2 (the Hanninen and Hell German patent); and
 - (e) an application for a patent PCT/DE95/00566. (the Hanninen and Hell European patent application).
2. During our inquiry, we have considered the scope of these patents, their legal and commercial effects, and the significance of litigation that is on foot in relation to them. We have also considered the steps that are open to an organization such as Zeiss to challenge the validity of a patent, and the methods available to the licensee of a patent, such as Bio-Rad, which wishes to enforce the patent. We have not sought to judge the merits of litigation that is pending, the validity of patents that are granted, or the merits of applications for patents. In our view, these are matters for the courts and patent offices properly seised of them. However, in assessing the situation we have taken our own view of representations made by Zeiss and Bio-Rad as to their legal and commercial options, and as to the consequences of the situation in which they currently find themselves. In particular we have taken our own view of two sets of assertions made at different times by Bio-Rad and Zeiss. These are, first, assertions as to the likelihood of Bio-Rad obtaining interim injunctions to prevent the manufacture and sale by Zeiss of multiphoton microscope systems. Second, as to the influence of a decision of the Board of Appeals of the European Patent Office (EPO) on the outcome of challenges to the validity of a patent in the UK, other European jurisdictions, and in the USA. In making our assessments we were assisted by Bristows, a firm of specialist intellectual property lawyers, which we instructed to advise on a number of issues.
3. In this appendix we will make a number of introductory points about patents, and the scope of patent protection, that are relevant to this inquiry. In so doing we are not attempting to state comprehensively the legal consequences that arise from the grant of a patent in all the jurisdictions in which Cornell, Zeiss, Leica or Bio-Rad have been

granted multiphoton microscope patents. We will then set out a chronology relating to the important microscope patents and relevant disputes. Finally, we will consider specific issues that have arisen in the inquiry.

Introductory points

4. A patent¹ gives its proprietor purely negative rights. In particular, the right to prevent a party from making a product or operating a process for a period of, normally, 20 years from the date of application in a particular country. The grant of a patent brings with it no positive right to make a product or to operate a process. An invention can be made which is, for example, an improvement of an existing idea embodied in, and protected by, another patent. It does not follow from the grant of a patent that the patentee will exploit its monopoly by selling a product made exactly in accordance with its patent. Where there are a number of possible variations described in a patent, the patentee will rarely use more than one of them.
5. The scope of the monopoly is defined by its claims. There are often different types of claim in a patent. In the Cornell European patent there are both product and method claims which fall to be considered separately. The independent claims are claims 1 and 6 (these are set out in Annex 2 to this appendix). There are also 'dependent' or 'subsidiary' claims, which are of narrower scope than the independent claims. Usually attention will focus on the independent claims in a patent dispute, but occasionally subsidiary claims can be important if the main claims are of suspect validity. Narrower subsidiary claims are sometimes capable of saving a patent which may be held 'partially valid'.
6. In order to infringe a patent claim, a product or process must normally contain all elements of the claim properly construed. The absence of any one element is enough to avoid infringement. It is possible for various types of person or entity to infringe a patent. A product claim can be infringed by a person selling the product; by a person buying (ie 'keeping') the product; or by a person selling an 'essential element' of a product. This last category of person is referred to as a 'contributory infringer'. They may not sell the entire product as defined by the claim, but may supply an essential element to a person who intends then to combine it with the remaining necessary elements. However, the supplier has to have a degree of knowledge in order to infringe.
7. The grant of a patent by a patent office is not determinative of its validity. It is a necessary but not a sufficient condition. Patents can be, and often are, challenged in post-grant opposition procedures and in courts. However, the grant of a patent is a significant impediment to doing business in goods covered by it, even where there is dispute as to the scope of the patent claim, because the patent will remain in force unless and until it is successfully challenged. Customers are often wary of dealing in goods that are alleged to infringe a patent, for fear of being caught up in a patent dispute themselves.

¹The grant of a patent is commonly said to be the grant of a monopoly right in respect of an invention for a limited period. The United States Patent and Trademark Office (USPTO) publishes a glossary of terms in which 'patent' is defined as 'a property right granted by the Government of the United States of America to an inventor "to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States" for a limited time in exchange for public disclosure of the invention when the patent is granted'.

8. In order to be valid, a patent has to satisfy various criteria, the most important of which are novelty and inventiveness.² To be patentable, an invention must be new—that is not disclosed anywhere in the world before. (There are slightly different rules in the USA, but for present purposes these differences are not important.) In addition, an invention must be inventive, which is defined in a circular manner as meaning that it must not have been obvious to a person of ordinary skill in the relevant art (the ‘notional skilled person’). Obviousness is very difficult to assess, since it depends on the level of knowledge and way of thinking of the notional skilled person. The alleged invention of a patent can be novel but still obvious. The strength of arguments of novelty and especially obviousness are in practice assessed differently in different patent offices and in different national courts. This, unfortunately, can lead to patents of different scope, or even the allowance of patents in some jurisdictions, but not others.

9. In the UK the right to sue for infringement of a patent rests primarily with the proprietor of the patent and with the proprietor’s exclusive licensees. We understand that this or a similar situation is the case in other jurisdictions relevant to our inquiry. In the UK, the relief that may be sought by the claimant in infringement proceedings includes damages, an order for delivery up, an injunction, and a declaration of validity. Again, we understand that similar remedies apply in other relevant jurisdictions. Although an interim injunction for infringement of a patent may lie in the UK if an application is made with sufficient haste, it is in practice difficult to obtain an interim injunction because of the suitability of damages as a remedy should infringement be shown. An application for an interim injunction must also be brought speedily in the Federal Courts in the USA. We understand that different criteria may apply in other jurisdictions. We have not assumed that the situation is the same in Germany, or in other jurisdictions, as it is in the UK or the USA, though we believe that delay is a factor in Germany. Where damages are awarded, the basis of the award may be lost profits or a reasonable royalty. In the UK, the successful party in patent litigation would normally expect to recover at least part of its costs from the losing party. This is not the case in the USA where there is normally no recovery of attorney’s fees, although a successful party may recover some disbursements.

Chronology

1989

10. On 14 November 1989 Cornell filed in the USPTO an application for a patent in relation to two-photon laser microscopy. On the face of the application the ‘inventors’ are described as Winfried Denk, James Strickler and Watt Webb. We understand Cornell to be the assignee of the invention from its inventors. It is common ground between Zeiss and Bio-Rad that by virtue of this application 14 November 1989

²See, for example, Article 52(1) of the *European Patent Convention* (EPC) ‘European patents shall be granted for any inventions which are susceptible of industrial application, which are new and which involve an inventive step’. The need for invention is commonly held to be such as to exclude discoveries from the scope of patent protection, though the EPC makes that express, see Article 52(2)(a).

became the priority date³ for all the two-photon laser microscopy patent applications subsequently made by Cornell around the world.⁴

1990

11. On 13 November 1990 Cornell applied under the Patent Cooperation Treaty (PCT) procedure for patents in jurisdictions including the UK, Germany and Japan. Messrs Denk, Strickler and Webb are identified as the inventors.⁵ The application is in relation to 'two-photon laser scanning microscopy'.

1991

12. On 23 July 1991 the application made by Cornell for a patent in the USA was granted by the issue of United States Patent 5,034,613.⁶ Cornell's US patent contains claims directed to a method of performing two-photon molecular excitation of fluorescence in laser scanning microscopy, and an apparatus (microscope) for performing the method. As to the light used in the excitation, part of the claim refers to 'a source of sub-picosecond monochromatic coherent light pulses...'

1994

13. On 28 April 1994 Pekka Hanninen and Stefan Hell applied for a patent in the Deutsches Patentamt in respect of a two-photon luminescence scanning microscope.⁷ 28 April 1994 appears to be the priority date for the various applications made in respect of this patent.

1995

14. On 27 April 1995 Pekka Hanninen and Stefan Hell made an application under the PCT procedure for patents in the USA and in 16 jurisdictions in Europe including the UK and Germany. In the application Messrs Hanninen and Hell are named as inventors and applicants. The application is entitled 'luminescence scanning microscopy process and a luminescence scanning microscope'. We understand that the EPO has yet to render a decision whether it will grant a patent.

1996

15. With effect from 1 July 1996⁸ Cornell granted a licence to Bio-Rad Laboratories Inc.⁹ The licence is the grant of the right to 'make, have made, use or sell' licensed

³The 'priority date' is the date by reference to which the issue of invention will be judged. Within the World Intellectual Property Organization (WIPO) system, an application for a patent in one jurisdiction may rely on the priority date in an earlier application in a different jurisdiction if the second application is made within one year of the first. Thus it seems that in making the 'PCT application' referred to in paragraph 11 within one year of its application in the USA, Cornell sought to rely on the date of its patent application to the USPTO as the priority date of its PCT application.

⁴The subsequent grant of this patent on 23 July 1991 means that, subject to challenge in the courts and the payment of fees, there is in force in the USA a patent in relation to two-photon laser microscopy until 13 November 2009.

⁵The subsequent grant of these patents means that, subject to challenge in the courts and the payment of fees, there is in force in those jurisdictions in relation to which patents were sought a patent in relation to two-photon laser microscopy until 12 November 2010.

⁶The patent notes that the invention was made with 'Government support' and that 'The Government has certain rights in the invention'.

⁷*Lumineszenz-Rastermikroskop mit zwei Photonen Anregun.*

⁸It appears from the signature page that the licence was not signed by Cornell until 2 August 1996. However, the licence is expressed to take effect from 1 July 1996.

⁹Including, broadly, its 40 per cent subsidiaries.

products¹⁰ in the field of microscopy¹¹ worldwide. A brief description of the main terms of the licence is included as the Annex 1 to this appendix.

1997

16. On 6 February 1997 Leica was granted a sub-licence of the Hanninen and Hell German patent (at that point, still the subject of an application) together with rights in relation to similar patents.

1998

17. On 15 May 1998 Zeiss wrote to Bio-Rad to advise Bio-Rad that Zeiss intended to market a laser scanning microscope in the USA and that it did not believe that sales would constitute a breach of Cornell's US patent because that patent was invalid by virtue of prior art.
18. On 2 July 1998 the Deutsches Patentamt granted Hanninen and Hell a patent for a two-photon luminescence scanning microscope.
19. On 7 July 1998 the USPTO granted a patent number 5777732 in respect of Hanninen and Hell's application under the PCT procedure. Hanninen and Hell's US patent is headed 'Luminescence-scanning microscopy process and a luminescence scanning microscope utilizing picosecond or greater pulse lasers'.¹²
20. On 1 August 1998 Zeiss offered for sale in the USA a laser scanning microscope that could be combined with a laser to create multiphoton excitement.
21. 2 September 1998 is the 'date of publication and mention of the grant of patent' of the patents applied for by Cornell at the EPO in relation to two-photon laser scanning microscopy. Effectively this means that those patents applied for in European jurisdictions by Cornell under the PCT procedure, Cornell's European patent, were granted on this date.¹³ The relevant jurisdictions include the UK and Germany. The effect in domestic law is that from this date the patent may be treated as a patent granted under the Patents Act 1977.¹⁴ The patent granted contains 'claims'¹⁵ set out in Annex 2 to this appendix (the numbers in the text of the claim refer to drawings in the patent).
22. On 6 November 1998 Cornell's application under the PCT procedure for a patent in Japan was granted. The patent was subsequently published on 29 January 1999.
23. Also on 6 November 1998 Zeiss filed suit seeking a declaration in the United States Federal District Court in the Southern District of New York that the microscope marketed by Zeiss in the USA did not infringe Cornell's US patent, or alternatively that Cornell's US patent was not valid. It appears that Zeiss's claims can be boiled down as follows.¹⁶ First, there is no infringement of Cornell's US patent because

¹⁰Licensed products is a defined term and includes any product, products, use or uses claimed in the Cornell US patent and its foreign counterparts, so the Cornell European patents, for example, are included.

¹¹Field of microscopy is a defined term. It means 'any and all uses of microscopes and applications of microscopy'. However, there is an exclusion in respect of uses or applications in human medical or veterinary therapy or diagnostics in which licensed products will be used on or in the living body and an example is given of *in situ* dermal surface analysis or endoscopy.

¹²Under the heading summary of the invention at line 41.

¹³There is a nine-month period in which a decision of the EPO can be challenged by Opposition proceedings. Disputes about infringement are exclusively matters for national jurisdictions, and validity can also be challenged at national level.

¹⁴Subject to administrative requirements.

¹⁵The claim defines the matter for which the applicant seeks protection by the patent.

¹⁶Though not all of the matters claimed by Zeiss, Bio-Rad or Cornell may have been included in their original pleadings.

Zeiss does not sell a microscope with a laser capable of generating two-photon excitation. Second, there is no infringement because the lasers used by Zeiss's clients are not of a sort falling within the matters claimed in the patent. Third, Cornell's US patent is invalid by reason of prior art. Fourth, it is invalid for a number of reasons based on technical objections to the application by which it was granted. Fifth, Cornell's US patent is unenforceable for reasons connected with the requirements on its inventors to disclose information.

1999

24. On 29 January 1999 Bio-Rad and Cornell filed a counterclaim seeking damages or other compensation for infringement by Zeiss of Cornell's US patent.
25. On 1 June 1999 Zeiss filed a notice of opposition with the EPO contesting the latter's grant of the Cornell European patent. Leica made its opposition on 2 June 1999.
26. On 20 July 1999 Zeiss filed an opposition to the grant to Cornell of its two-photon patent in Japan.
27. On 16 December 1999 Zeiss, Bio-Rad and Cornell began discussions with a view to the settlement of the US proceedings.

2000

28. On 8 August 2000 the Japanese Patent Office upheld the Japanese two-photon patent.

2001

29. On 26 January 2001 the Deutsches Patentamt revoked Hanninen and Hell's German patent on the opposition of EVOTEC Biosystems AG.
30. On 22 February 2001 Leica lodged an appeal in the Bundespatentgericht against the revocation of Hanninen and Hell's German patent.
31. On 6 March 2001 the Opposition Division of the EPO held that Cornell's European patent should be revoked in its entirety. The reasoning is complicated, but the decision of the Opposition Division appears to be that the claimed subject matter is not inventive; that is it is obvious in the light of prior art.
32. On 15 May 2001 Bio-Rad filed an appeal against the revocation decision of 6 March 2001.
33. On 28 to 30 August 2001 a hearing was held in the United States Federal District Court for the Southern District of New York on the construction of the claims¹⁷ in Cornell's US patent (a 'Markman' hearing). The purpose of a Markman hearing is to determine the meaning of the claims in the patent.

¹⁷In the USA the interpretation of the claims set out in a patent is a matter of law. That is, it is for the court to decide the scope of the claims. The question of infringement of the patent is a question of fact, and is left to the jury. This approach, and the terminology, is derived from the judgment of the Supreme Court of the United States in *Markman v Westview Instruments* 517 U.S. 370.

2002

34. On 4 February 2002 the United States Federal District Court gave judgment on the construction of the claims in Cornell's US patent (a Markman judgment). On each point of construction raised, the court appears to have adopted, or substantially to have adopted, Bio-Rad's interpretation of Cornell's US patent.
35. On 21 November 2002 the Technical Board of Appeal of the EPO gave its decision in Bio-Rad's appeal against suspension of Cornell's European patent. The appeal was allowed and, with some modification of parts of the patent other than the claim, the patent was maintained.

2003

36. On 14 October 2003 Bio-Rad and Zeiss entered into an agreement for the sale and purchase of the laser scanning microscope business of Bio-Rad's cell science division.
37. On 17 October 2003 the proceedings in the United States Federal District Court were placed on the suspended calendar.
38. On 16 October 2003 Hanninen and Hell's German patent was finally revoked by Bundespatentgericht.
39. On 11 November 2003 Leica filed a plea of nullity in the Bundespatentgericht challenging the grant of Cornell's European patent within Germany. The plea discloses a number of ways in which Leica claims that the patent is invalid for lack of inventiveness (is obvious in the light of the prior art).

2009

40. On 13 November 2009 Cornell's US patent will expire.

2010

41. On 12 November 2010 Cornell's European patent will expire.
42. To summarize the position, we can say the following. First, that in relation to sub-picosecond laser scanning microscopes there are at present patents granted in the USA, the UK, Germany and elsewhere. Bio-Rad has the benefit of these patents under licence from Cornell. There are currently proceedings in the USA by which Zeiss challenges the validity of Cornell's US patent. In the same proceedings Bio-Rad has sued Zeiss for infringement. Zeiss has disputed that it has infringed Cornell's US patent. Those proceedings are suspended, and no judgment on validity or infringement has been given. In Germany, Leica has challenged the local validity of Cornell's European patent. No judgment has yet been given.
43. Second, that in relation to picosecond laser scanning microscopes there is at present a patent granted in the USA, and an application for a patent in the UK and Germany. We understand that Leica has the benefit of the patent and the applications. Hanninen and Hell's German patent has been revoked.

Issues of particular importance that have arisen during the inquiry

44. Three issues of particular significance that have arisen in relation to Cornell's US patent and Cornell's European patent are these. First, the scope of the protection that they offer in relation to the supply of different types of microscope equipment, or the supply of services in relation to two-photon laser scanning microscopes. Second, the effect that the decision of the Board of Appeals of the EPO to reinstate Cornell's European patent would have on infringement or invalidity actions in the UK, Germany, and the USA. Third, whether products made in accordance with Hanninen and Hell's US patent infringe Cornell's US patent.

(i) The scope of the protection afforded by the Cornell patents

45. The scope of Cornell's US patent and of Cornell's European patent is important because Bio-Rad has claimed in the US litigation that the sale of something less than a full two-photon laser scanning microscope with a subpicosecond laser can constitute infringement. The same issues arise in relation to Cornell's European patent. In paragraphs 46 to 51 we set out our understanding of the relevant issues from the standpoint of domestic law.
46. Where a patent claim relates to a product, such as the two-photon laser scanning microscope in claim 1 of Cornell's European patent, it is an infringement of that patent to do any of the following things in the UK without the consent of the proprietor: 'to make, dispose of, offer to dispose of, to use or to import the product or keep it, whether for disposal or otherwise'.¹⁸ Accordingly, the manufacture in the UK without licence of an entire two-photon laser scanning microscope apparatus that falls within the scope of claim 1 of Cornell's European patent will constitute an infringing act. Similarly, importation into the UK of such apparatus, if manufactured abroad, will constitute an infringing act, as will any advertisements for sale or actual supply of such apparatus in the UK.
47. As infringement under this section also extends to the 'use' of the product. It encompasses acts carried out by customers and end users. A customer will be an infringer of the product claim by virtue of keeping and using a two-photon laser scanning microscope.
48. The existence and use of scanning microscopes was known in the field of microscopy prior to the invention claimed in the Cornell European patent. Similarly the existence and use of subpicosecond lasers was known within their respective fields prior to this date. The sale and use of scanning microscopes and the sale and use of subpicosecond lasers for their original purpose, that is not use in combination in a two-photon laser scanning microscope, should not, on its face, constitute an infringement of Cornell's European patent.
49. However, the situation is more complicated when considering infringement relating to the supply of, or offers to supply, the component parts of a two-photon laser scanning microscope apparatus without licence, such as would be the case when considering upgrading an existing system. It is possible to 'indirectly' infringe a patent by committing what is known as 'contributory infringement' under section 60(2) of the Act. Contributory infringement is defined as follows:

¹⁸Section 60(1)(a) Patents Act 1977.

a person (other than the proprietor of the patent) also infringes a patent for an invention if, while the patent is in force and without the consent of the proprietor, he supplies or offers to supply in the United Kingdom a person other than a licensee or other person entitled to work the invention with any of the means, relating to an essential element of the invention, for putting the invention into effect when he knows, or it is obvious to a reasonable person in the circumstances, that those means are suitable for putting, and are intended to put, the invention into effect in the United Kingdom.¹⁹

To commit an act of contributory infringement it is necessary to supply or offer to supply 'means, relating to an essential element of the invention' without licence.

50. In contributory infringement the state of mind of the supplier of the equipment is very important. If the supplier knew that the individual item was suitable for putting the invention into effect and intended to put the invention into effect, then the supply or offer to supply would amount to an infringing act. There may even be infringement based on constructive knowledge.
51. It seems therefore that in the case of scanning microscopes there is a range of acts that might constitute 'contributory infringement' from the sale of microscopes that are potentially suitable for upgrade but are not sold as such, to microscopes that are explicitly advertised or sold as being suitable for upgrade.

(ii) The effect of the decision of the Board of Appeal of the European Patent Office

52. During the course of the inquiry the influence of the decision of the Board of Appeal of the EPO to maintain Cornell's European patent (see paragraph 35) has been canvassed widely. The EPO is a patent-granting body. The opposition process is an extension of its patent-granting function, but involving third parties. However, it is not a court and does not, for example, take evidence from live witnesses. It decides matters largely by reference to written submissions even though there is a final oral hearing which will typically last half a day to a day in major cases. As a result, challenges in national patent courts to the validity of patents that have survived the EPO opposition process are not futile. This is especially so in the UK where in practice EPO decisions are not treated as decisive. Whilst EPO decisions on points of law are highly persuasive, it does not follow that decisions in individual cases will be followed, because the EPO will not have had the benefit of hearing the evidence put before the Court.
53. There is no appeal from the decision of the EPO Board of Appeal. Consequently, and subject to what is said below, provided that renewal fees are paid in the individual countries designated, Cornell's European patent will remain valid and in force in all of the designated states until it expires after 20 years from filing.
54. It is not possible to challenge the patent centrally, since there is no central European patent court. A challenge to the patents would therefore have to be brought in the individual national courts having jurisdiction over patent matters. This could be done either by way of an application to revoke the patent or alternatively²⁰ as part of a defence to a claim for infringement.

¹⁹Section 60(2) Patents Act 1977.

²⁰Although in Germany different courts will hear infringement and invalidity actions.

55. The position in other European countries differs from the position in the UK, in that varying degrees of weight will be given to the decision of the EPO, particularly at Board of Appeal level depending upon the jurisdiction and form of litigation. This is not to say, however, that it will be futile in any jurisdiction to attempt to revoke a patent which has been upheld by the Board of Appeal. For example, in Germany the Court may appoint its own expert who will have his or her own opinions which will hold sway with the Court. It will be noted, for example, that Leica has not been dissuaded from challenging Cornell's European patent in Germany notwithstanding the findings of the EPO.
56. Multinational patent litigation concerning high-value products is relatively common. Even in the most valuable of cases, however, it is extremely rare for litigation to be ongoing in more than about three European jurisdictions—typically the UK, Germany and The Netherlands. In a typical case, actions in such jurisdictions will be regarded for practical purposes by the parties as a precedent for the whole of Europe, such that there will be a de facto if not actual settlement of the parties' differences following one or perhaps two national decisions.
57. The result of patent litigation can differ from country to country. This is due to the different legal systems, the nature of the evidence adduced (which may not always be the same due to differences in procedural rules and local advice as to how best to present the case) and to the overall standard required for inventiveness by the individual courts. With regard to this latter point, it should theoretically be the case that the standard is the same in all EPC countries. However, in practice standards do vary. We understand the UK is currently perceived as less favourable towards patentees.

(iii) Do products made in accordance with the Hanninen and Hell patents infringe Cornell's patents?

58. During the course of our inquiry we have considered whether picosecond laser scanning microscopes of the sort patented by Hanninen and Hell infringe Cornell's patents. Our understanding is that they do not. We have asked Zeiss whether it believes that picosecond laser scanning microscopes infringes the Cornell patents. Zeiss told us that it does not understand the Cornell patents to be infringed by the sale of picosecond laser scanning microscopes.

Terms of the licence between Cornell and Bio-Rad



The claims of Cornell's European patent

Claims

1. Apparatus (10) for laser scanning fluorescence microscopy of a target material (20) said apparatus comprising;
stage means (22) bearing target material (20) including a fluorescent component responsive to excitation by a photon of a characteristic energy to produce a fluorescence photon;
focusing means (40,12) positioned to direct light toward said stage and having an object plane (18) in said target material (20) at said stage means (22);
a repetitive source (16) of subpicosecond monochromatic coherent light pulses comprised of photons of energy less than said characteristic energy;
detector means for detecting said fluorescence photons (54);
means directing said coherent light pulses along an optical path including (40,12)said focusing means focusing said light pulses at a focal volume (26) on said object plane (18) to impinge on said target material (20) at said stage means (22) so that two-photon excitation induces said fluorescence photons in said fluorescent component; and
means for directing said fluorescence photons from said focal volume (26) to said detector means (54).
2. The apparatus of claim 1, wherein said light from said source (16) is focused by said focusing means (40,12) to form said focal volume (26) of a submicron diameter.
3. The apparatus of claim 1 or claim 2, wherein said focusing means (40,12) focuses said wavelength light into a conical configuration to produce converging and diverging light on opposite sides of said object plane (18), whereby said light is concentrated at said focal volume (26) on said plane (18)
4. The apparatus of any preceding claim, wherein the relative positions of focal volume (26) and stage means (22) are variable.
5. The apparatus of any preceding claim, wherein said focusing means (4,12) focuses said light at said focal volume (26) in said target material (20) to produce a light intensity which excites fluorescence in a limited ellipsoidal volume.
6. A method of laser scanning fluorescence microscopy by a two-photon excitation technique of a target material (20) containing a fluorescent component which is excitable by a photon of a characteristic energy to produce a fluorescence photon; by the steps of
repetitively illuminating said material (20) with a beam of intense, subpicosecond pulses of monochromatic coherent laser light comprising photons of an energy less than the said characteristic energy; and
focusing said illumination to a small focal volume (26) within said material (20) to produce an illumination intensity sufficiently high only at said focal volume

to produce molecular excitation by simultaneous absorption of two of said incident illuminating photons to evidence fluorescence in said fluorescent component, and detecting the fluorescence induced.

7. The method of claim 6, wherein the energy of the incident photons is half the characteristic energy.

These claims, though not identical to those in Cornell's US patent, are very similar to them. There is no suggestion of which we are aware from the parties that there is a material difference between the two claims.