

Patenting nanotechnology: are we on the right track?

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Abstract

Nanotechnology, the technology that brings the atom-by-atom manipulation of matter within reach, holds the promise of many societal benefits, such as dramatic progress in healthcare, environmental benefits and further advances in computing. Patents will be of crucial importance if innovation in nanotechnology is to live up to the expectations placed upon it. However, questions can be raised with the large number of patents granted for nanotechnology and the basic character of some of these patents. Impenetrable patent thickets or patents with great blocking power may be created right now. This chapter investigates whether patent law is being applied adequately with a view to realising the full innovative potential of nanotechnology and its societal benefits. It will not deal with the question of whether nanotechnology is patentable per se, but will focus on the way in which patents are currently being granted.

1 Introduction

Nanotechnology is the technology of the smallest objects. It holds the promise of manipulation on an atom-by-atom basis and represents the ultimate control over matter. The European Patent Office (hereinafter: EPO) defines nanotechnology as follows (Kallinger 2007):

“The term nanotechnology covers entities with a controlled geometrical size of at least one functional component below 100 nanometres in one or more dimensions susceptible of making physical, chemical or biological effects available which are intrinsic to that size. It covers equipment and methods for controlled analysis, manipulation, processing, fabrication or measurement with a precision below 100 nanometres.”

Potentially great societal benefits are in the offing. In healthcare, nanotechnology could bring advances such as selected targeting of cancer cells or clean drinking water in developing countries. For the environment, nanotechnology could bring benefits such as fuel saving additives, more efficient production of solar cells, cleaner generation of hydrogen, quickly rechargeable batteries and better insulation of buildings (Walsh 2007). In computing nanotechnology brings even smaller chips than the current ones with more memory capacity. It is expected that many new products can be developed on the basis of nanotechnology and the quality of existing products may be vastly improved (Pen 2009). However, the benefits of nanotechnology will only materialise if laboratory results can be adequately translated into innovations, so that new products and services are placed on the market. Patents traditionally play an important role in stimulating innovation. There is no doubt that inventions in the field of nanotechnology can be protected by patents (Bowman 2007, Newberger 2003). However, certain developments indicate that we may not be using patent law in a way that extracts the most from the innovative potential that nanotechnology offers. In literature concerns have been voiced that patents are being granted on building blocks of the technology, such as relatively simple molecules (Lemley 2005, Zekos 2006). If these concerns are justified, some patents in nanotechnology would be very valuable, but they would also have an enormous potential to block. The same holds for patents on the underlying principles of

nanotechnology. They would afford too much power to pioneering innovators and upstream researchers. The eagerness to patent nanotechnology also raises concerns about the number of patents. Using its wide definition of nanotechnology, the EPO identified about 108,000 patent documents relating to inventions in the field of nanotechnology (Kallinger 2007). The existence of many patents in the field of nanotechnology could hamper downstream innovation. These concerns are as of yet not empirically validated. This chapter will however show that nanotechnology possesses a number of characteristics that give credence to the concerns raised. Although that does not amount to proof of a problem, it will be argued that there is a definite risk that the concerns prove to be justified. This chapter further argues that the risk is serious enough to consider certain intra-systemic steps to make the patent system function better, so that some barriers to innovation in the field of nanotechnology are taken away and society is better placed to reap the fruits of nanotechnology. Where possible analogies with biotechnology are drawn. Biotechnology has seen a relatively recent scientific and technological growth and it experienced to a large extent the same problems with respect to patents that nanotechnology faces now.

The outline of the chapter is as follows. The second section shows in what respects nanotechnology differs from existing technologies and what adverse implications this may have for innovation. In the third section a number of avenues for addressing the issues mentioned in the second section are identified.

2 The uneasy relation between nanotechnology and the patent system

The patent system is designed to spur innovation. Nanotechnology has however some characteristics that hinder the patent system in stimulating innovation. I will consider here three characteristics in particular. In the first place nanotechnology is science based. Secondly, it is interdisciplinary and finally it crosses the borders of industries. I will first deal with the scientific nature of nanotechnology.

2.1 The scientific nature of nanotechnology

The scientific character of nanotechnology has a number of implications for the application of patent law. Some of these implications nanotechnology shares with biotechnology that also was and is very much science based. I discern the following implications: universities are relatively over represented amongst the patentees. What is patented may lie close to results of fundamental research. The ensuing patents may have great blocking power. The transfer into marketable products often still requires non-obvious steps. The patentability of inventions can only be adequately ascertained by somebody having good knowledge of the academic discussion and literature in the field of nanotechnology. Hereinafter, I will elaborate these implications of the science based character of nanotechnology

Nanotechnology is a technology that is still very much the subject of fundamental research, much of which is performed by universities and research-institutes. In Europe, two thirds of the research into nanotechnology is publicly funded, compared to only 45% in the US (Hullmann 2006, p. 15). This relatively low percentage can be attributed to the huge private investment in the US in nanotech research. Both in the US and Europe many public funds are spent on nanotech research. Universities appear to be particularly avid patentees. They are also in a relatively strong position when negotiating licenses on their patent portfolio. Since they are not in the business of manufacturing goods their

need to obtain licenses from other patentees are relatively low. That makes them much less vulnerable for an accusation of patent infringement and that in turn gives them leeway when negotiating the conditions for licenses on their own patent portfolio (Lemley 2008). In reality things are of course a bit more complicated than described here (Shrestha 2010, Zvoko 2006). Universities may feel that it is their moral duty to make sure that their research results find wide application in society and this may ring through in their licensing policies. Universities are also for other than patent reasons dependent upon commercial companies. They will want to maintain good relations with commercial companies for purposes, such as contract research and access to expensive equipment. This circumstance may also make for a more balanced situation in negotiation room. Nevertheless, there will be great differences between the licensing policies of universities and for a university not each company may be as important as those with which it maintains close ties. These multifaceted situations will translate in a wide variety of constellations for license negotiations. Therefore, licenses on patents held by universities may not always be as easy to obtain as may be thought in first instance.

Since research with respect to nanotechnology is to a large extent performed by universities, much of it bears a fundamental character. Basic ideas, substances and processes are being developed. Just as with biotechnology, fears exist that the building blocks of the technology will end up being patented. In biotechnology, upstream research results, such as DNA sequences, were patented while being far removed from a product or service that could readily be offered on the market (Rai 1999 and Rai 1999a). Such patents may hinder further research (Kane 2006). They merely seem to reserve a certain research field for a patentee. According to US patent law expert Lemley, it is likely that similar risks are present in the field of nanotechnology (Lemley 2005). In other technical fields, such as computers, software, the internet, and – surprisingly - biotechnology, Lemley observes that patenting started only after development of the technology was in full swing. In nanotechnology, patents were granted directly from the start of the scientific development. As a consequence, in the nanotech industry patents on the basic ideas – the building blocks - of the technology would be more prevalent. This could burden downstream innovators as it is practically impossible to invent around basic ideas and elements of a discipline. It is hard to assess exactly to what extent this problem materialises in nanotechnology. Such assessment is further hampered by the fact that nanotechnology is not one homogeneous technology. It is a collection of several sciences and technologies that have a small size in common. The situation of the various nanomaterial platforms – basic molecules - can be very different. Examples of nanomaterial platforms are inter alia carbon nanotubes (hereinafter: CNTs), buckyballs or fullerenes and quantum dots. From platform to platform there are differences between the density of the patent landscape and the degree in which patents are entangled. This becomes all too evident when comparing the patent landscapes for buckyballs and carbon nanotubes. There are no broad patents claiming buckyballs per se (Lemley 2005, p.614). A reason may be that buckyballs spontaneously occur in nature (Gerhardt et. al. 1987) and therefore may be unpatentable discoveries. At the same time, carbon nanotubes per se are being claimed in a number of patents. Three patents are often mentioned because of their broad scope: US5747161 a patent of NEC, US5424054 a patent of IBM and US6683783, a patent of Carbon Nanotechnologies (Lemley 2005 and Harris & Bawa 2007). A fourth patent should be mentioned in this respect as well: US4663230, a patent of Hyperion. The latter patent concerns a composition of matter using carbon nanotubes. Its first claim reads:

An essentially cylindrical discrete carbon fibril characterized by a substantially constant diameter between about 3.5 and about 70 nanometers, length greater

than about 102 times the diameter, an outer region of multiple essentially continuous layers of ordered carbon atoms and a distinct inner core region, each of the layers and core disposed substantially concentrically about the cylindrical axis of the fibril.

This is a broad claim and applications using carbon nanotubes must closely guard that they do not infringe this patent. A patent application for the invention has also been filed in Europe (EP0205556). The European patent's first claim is however narrowed down by the inclusion of an extra qualification: 'said fibril is substantially free from pyrolytically deposited thermal carbon'. In Europe, a purer form is claimed, but even though it remains a rather broad patent. In conclusion, when considering carbon nanotubes and buckyballs as building blocks, it appears that the former are the object of broad patent claims whereas the latter not or at least much less so.

It could be asked whether these differences have predictive value for the level of innovation. Starting from traditional concerns about the effects of patents on building blocks, one would expect that innovation in carbon nanotubes would suffer. However the opposite seems to be the case. When looking at the number of patent applications, it appears that there are five times as many applications for CNTs than there are for buckyballs (Michalitsch et. al. 2008, p. 86). The buckyball patent landscape also shows many abandoned patents (Lux Research 2005). These patent based indications are in accordance with the trend signalled in literature: expectations for carbon nanotubes are high (Harris & Bawa 2007). Buckyballs have disappointed in not living up to the high expectations that were placed upon them when they were first discovered (Michalitsch et. al. 2008, p. 86, Ball 2005).

So perhaps the potential for technical and commercial success are more important indicators for innovation than the existence of patents on building blocks. That does however not take away that innovation might have been higher if patents on building blocks would not have existed in the first place. The building block patents may very well create uncertainty, because it may be unclear whether innovative activities are covered by the patents and if so, it may be unclear whether the patents are valid. Especially the uncertainty may have adverse effects on innovation. Concerns about patents on building blocks can therefore not be discarded and may need to be addressed.

The building blocks of nanotechnology must ultimately lead to concrete products and services so that the great expectations about the benefits that nanotechnology can yield are met. Yet, it has hitherto proven difficult to translate theoretical results into marketable products. Only a few products have appeared on the market. In this respect, Europe is lagging behind the US (European Commission 2004, p. 7). This may indicate that patents are being granted on inventions that have no or at least a very thin industrial applicability. This reinforces the fear expressed above that patents may be granted on basic ideas in nanotechnology.

According to research by Meyer, nano-patents tend to cite only other patents and to a much smaller degree scientific research papers (Meyer 2001, p. 298). This is remarkable in view of the fact that nanotechnology is very much a science based discipline. This raises the question whether relevant prior art escapes the patent examiners' attention. If this is the case, patents are being granted on invention that are not novel or lack inventiveness.

2.2 The interdisciplinary and cross-industry character of nanotechnology

Above it was shown that the scientific character of nanotechnology sits uneasily with the patent system. This section investigates how the patent system relates to the interdisciplinary and cross-industry character of nanotechnology. The former will be dealt with first. The manipulation of matter on the nanometer level is not the prerogative of one single technological discipline. Nanotechnology is thoroughly interdisciplinary and its applications often are the result of a convergence of pre-existing technologies. Disciplines involved in nanotechnology are, *inter alia*, chemistry, physics, biology, and electronics. The interdisciplinary character may mean that nanotech patent applications sometimes end up with examiners having expertise X while other similar applications end up with examiners having expertise Y. The divisions between examiners with different expertises holds a certain risk for overlooking prior art.¹ Also the lack of a uniform terminology in nanotechnology may magnify the risk of prior art remaining undetected. Biotechnology has not or to a much lesser extent been burdened by these problems. Therefore, from the interdisciplinary nature of nanotechnology, a certain risk of patents being granted for inventions that are not novel or inventive can theoretically be deduced. Such a theoretical risk does not amount to empirical evidence supporting a claim of overpatenting. Empirical evidence is sparse (Featherstone and Specht 2004). The EPO and the organisation on Economic Cooperation and Development (hereinafter 'OECD') are working on monitoring instruments for nanotechnology patents (Hullmann & Frycek 2007, p.11-12). These may begin to enlighten us on the empirical aspects of patenting in the field of nanotechnology. Even in the absence of empirical evidence, the theoretical reflections about the interdisciplinary character of nanotechnology point to deficiencies that may need to be addressed.

Apart from crossing the boundaries of scientific disciplines, nanotechnology also crossed the boundaries of industries. The cross industry character is mainly important for the manufacturing stage of nanotechnology. It may expose innovators to a greater risk of being accused of patent infringement (Khanijou 2007). On the one hand, this is due to patentees from other industrial sectors who may feel less inhibited to enforce their patents against innovators outside their own industrial sector. On the other hand, this problem is exacerbated by the added complexity of compliance checking. A company becoming active in the field of nanotechnology cannot limit its compliance checks to the industrial sector in which it is active. A company will need to check patents in other industries as well since these patents may read on its activities. Given the size of patent databases, the search for relevant patents may amount to gigantic task. In this respect, the patent landscape of nanotechnology is more complex than is the case with biotechnology, where the number of industries involved is very limited. In view of the fact that most nanotechnology products and services have not yet reached the market and yet relatively little money is made with nanotechnology, the extent of the problem may not yet be visible in its entirety.

3 Addressing the friction between nanotechnology and the patent system

Above we have seen that there are multiple reasons for fearing that frictions between nanotechnology and the patent system prevent the former from realising its full potential. Hereinafter, a number of avenues are investigated for redressing this situation.

3.1 Person skilled in the art

In patent law, a fictional person skilled in the art is used as a criterion figure. For example, when assessing the inventiveness of an invention it can be asked according to whom the invention needs to be inventive. Technical teachings that a layman finds inventive, an expert in the field may find obvious. Patent law solves the issue by requiring that an invention is inventive from the perspective of a person skilled in the art. This person skilled in the art is usually defined as a person working in the technological field in which the invention falls and he is considered to have average knowledge and abilities. By choosing the person skilled in the art as a criterion figure, the patentability requirement of inventiveness is made more objective. Apart from the requirement of inventiveness, there are other requirements that a patent must meet and for which the criterion figure is relevant. An invention must for example also be sufficiently disclosed in the patent. This means that it must be possible to rework the invention based on the information provided in the patent. Here again, the question can be asked who should be able to rework the invention. Here too, the issue is resolved by choosing the person skilled in the art as the standard by which to measure whether the requirement has been met.

The definition of the person skilled in the art is highly relevant for the determination of novelty, inventive step and sufficiency of disclosure in nanotechnology. If the person skilled in the art is taken to be highly qualified it is more difficult to meet the inventive step requirement, but the disclosure of the invention can be somewhat less encompassing. The person skilled in the art can be assumed to be more adept in applying the technical teaching of the patent. The opposite also holds: defining the person skilled in the art as less highly qualified, makes it easier to meet the inventive step hurdle, but obliges a more encompassing enabling disclosure. In a new field, such as nanotechnology, it is unclear how the person skilled in the art of nanotechnology is to be defined.

The interdisciplinary character of nanotechnology has a bearing on the definition of person skilled in the art of nanotechnology. For example, the interdisciplinary character may mean that the person skilled in the art should be a master of many disciplines. This leaves open the question what disciplines he should master. The function of the concept points the way: with the help of the fictitious person skilled in the art, it must be possible to determine what activity would be considered normal progress in the art and what would be considered to be a major step in the pertinent technology. So, the person skilled in art should reflect the realities in the relevant industry, in this case, the pertinent branch in the nanotech industry. This indeed means that multidisciplinary talents must be attributed to the person skilled in the art. Apart from the abstract question of how to define the person skilled in the art, there is the practical issue that the concrete capabilities of patent examiners may rub off on their perception of the person skilled in the art. In other words, the monodisciplinary restrictions in the capabilities of examiners may influence their perception of the person skilled in the art. Thus, a tendency towards a lightly qualified person skilled in the art may result, where even the lightness of qualification may be different between patent examiners. An examiner may be more inclined to view aspects of an invention as inventive if they are in technology domains with which he is less familiar. Being less adept in reading a patent in such technology domains an examiner may also require a further elaborated disclosure. This effectively comes down to having a less highly qualified person skilled in the art as the criterion. It could be objected that it is not the patent examiner, but the courts that have the last say on what constitutes a man skilled in the art. Nevertheless, the determinations of a patent examiner are relevant, since most patents are never litigated. Nanotechnology litigation is still sparse compared to litigation in other domains. It will probably only begin to increase when products incorporating nanotechnology are

placed on the market on a large scale. Where patents are litigated the patent examiner sets the scene for the judgements of the court. For the time being there may be variation in the actual standards used in nanotechnology patenting.

Patent applicants may try to use the interdisciplinary character of nanotechnology to their own advantage by engaging in what I call 'technology shopping'. A nanotech patent may e.g. concern biological switch. The invention could be dealt with as an electronics invention, but alternatively as a biotechnological invention. By adequately formulating the claims in terms of a certain 'participating' discipline the patent applicant may try to steer the patent examiner away from relevant prior art. In the same way, it may also be possible to select the standards applicable to the determination of the person skilled in the art, and in its wake, novelty, inventive step or sufficiency of disclosure, since those differ to a larger or smaller extent between disciplines. For inventions in the field of biotechnology, research is usually done by postdoctoral researchers. The person skilled in biotechnology is accordingly more highly qualified than in most other arts (Hacon & Pagenberg 2008, p. 51). At the same time, biotechnology apparently is qualified as more uncertain science, where a person skilled in the art can not as easily as in other sciences assume the presence of fixed patterns. This reflects on the definition of the person skilled in the art. The Technical Board of Appeal has defined the person skilled in the art of biotechnology as follows (T 0387/94, *Max-Planck-Gesellschaft/Monsanto*): 'His/Her attitude is considered to be conservative. "He/She would never go against an established prejudice, nor try to enter unpredictable areas nor take uncalculable risks".' If an invention lends itself to a choice of art, a patent attorney may be able to select a favourable base discipline. By framing the invention in a suitable way, he can thus choose the standard applicable to his invention.

A team approach to a person skilled in the art may solve some of the inherent problems associated with the interdisciplinary nature of nanotech inventions. Dependent upon the implementation of a team approach there are different effects. The selection of an implementation therefore calls for a balancing of the effects. One of the implementation decisions to be made involves the qualification of the team skilled in the art which may be chosen higher or lower. If the imaginary team is chosen to be a very well qualified team this may raise the bar of inventiveness for nanotech inventions and may make the disclosures difficult to comprehend for any individual trying to make sense of a nanotechnology patent. After all, the drafter of the patent (probably a real life team) may presuppose all the knowledge available in the imaginary team. It may be contended that this is of limited relevance because any actor involved in nanotechnology works within multidisciplinary teams. However with a view to openness and accountability to the 'outside world' better readability of patents is relevant and requiring that an individual be able to read and understand a patent does not seem to be a too exaggerated demand. Therefore, I tend to think that the imaginary individual partaking in the team should be chosen as being somewhat less qualified than the person skilled in the art relevant for monodisciplinary inventions. This will force somewhat more elaborate disclosures in interdisciplinary inventions.

Another way to get 'better' disclosures would be to decouple the inventiveness-person-skilled-in-the-art from the sufficient-disclosure-person-skilled-in-the-art. This would be a more principled intervention in patent law that would require further research and for the time being nanotechnology does not present us with the necessity to do so.² Defining the person skilled in the art as a team and backing this up by making real life interdisciplinary teams, comes quite some way in resolving a possible technology shopping problem. A team of examiners is harder to fool than an individual examiner. At the same time, it must be admitted that a multidisciplinary team of examiners does not solve all problems. After all, it is still unclear how to determine the default discipline of an

invention, or, to say it in other words, what standards to use when examining nanotech patents.

3.2 Novelty and inventive step

As a new technological field, there is relatively little prior art and even less prior art explicitly relating to nanotechnology (Zekos 2006, p.366). A small reservoir of prior art may have the effect of lowering the actual novelty threshold, because novelty is easy to establish. Possibly, this gives rise to broad patents because the formulation of the claims does not have to steer clear from much prior art. The issue of the broadness of nanotechnology patents gains extra weight in view of the fact that nanotechnology is in its formative stages of development. The progress made in this stage may yield building blocks on which many later applications will be founded. On the one hand, the broadness of patents now granted may affect follow-on innovators negatively. On the other hand, broad patents may be necessary to recoup the large investment needed for developing laboratory findings into marketable products (Lemley 2005, p.628-629). Whether broad patents in nanotechnology are at the moment a good or a bad thing is open for discussion. Nevertheless, there can be little discussion that overbroad patents that should not have been granted in the first place must be avoided. An adequate determination of the state-of-the-art is central to the quality of granted patents. Although it is the patent applicant that must indicate what the nearest state-of-the-art is, it is up to the patent office to detect any deficiencies. This may be an extra heavy burden in the case of nanotechnology, since it is an emergent technology and patent offices struggle to find qualified examiners. The workload of the present examiners is already very high (Barraclough 2007 and Krempel 2006). In order to ease their workload, patent offices could invest in qualified examiners and in optimising the availability of prior art information, such as technical information in academic journals and other non-patent information. Another avenue through which progress could be booked is by working on a standard terminology and metrology in nanotechnology. This is of course not the task of patent offices but that of standard setting organisations, such as ISO and ASTM International.

First standards on nanotech terminology have already been adopted (ISO, 2008, ASTM Int'l 2006) or are in the process of being developed (ASTM Int'l 2009). ISO standard TS 27687:2008 on terminology and definitions for nano-objects was adopted in 2005 and is the first in a planned series of ISO standards covering terminology and definitions for various aspects of nanotechnology. In 2007, the OECD set up a Working Party on Nanotechnology. It explicitly addresses the issue of standardisation in nanotechnology (OECD 2008). However, the work of standard setting organisations often progresses slowly. A technology may not be developed enough to know what standards concerning semantics, measurement and testing are needed. This seems to be the case with respect to nanotechnology. Terminology in nanotechnology literature is extremely dynamic (Hullmann & Frycek 2007a, 396). Obviously, it is desirable for patent offices to work with standards that have been set by standard setting organisations especially if they are adopted globally. That makes communication with patent applicants easier. Internal communication between the various divisions within a patent office would benefit as well. It makes it also easier to detect prior art in patent databases and other literature sources. It may help in clarifying ambiguities in patent claims, making the scope of patents clearer, both for patentees and third parties such as competitors and licensees. Given the interest that standards on terminology and metrology represent for the patent system it seems to me that an argument could be made for active participation of patent offices in standard setting procedures. On the one hand, patent

offices have an important role in the patent system as gatekeepers for the patentability of nanotechnology inventions. In fulfilling this role they are highly dependent on a uniform terminology and metrology in nanotechnology. Differences in terminology and metrology can have far reaching implications, ultimately that patents are granted that should not have been granted in the first place. Patent offices should therefore make sure that their standardisation needs are taken into consideration. On the other hand, patent offices being in the unique position they are in see many applications from various domains of nanotechnology and thus could deliver an important contribution to the standardisation process. In short, there is good reason to have patent offices participating in standard setting processes concerning terminology and metrology.

3.3 Industrial applicability

In situations of technological change, such as with emerging technologies, there is a certain risk that broad patents are being granted on enabling technology. This has possibly been the case in biotechnology where patents have been granted on upstream research results (Heller & Eisenberg 1998; Zekos 2006a). Theoretically, the requirement of industrial applicability could be used as a brake on overbroad, upstream research patents which are far removed from a product that could be placed on the market. Given their abstract character, they may have no 'practical' application. In reality, however, the EPO hardly uses the industrial applicability requirement for this purpose (EPO 2006, p. 170-171).

In the field of biotechnology, it has been tried to use industrial applicability for just that purpose. The European Directive on biotechnological inventions Article 5(3) Directive 98/44/EC indicates that the industrial application of a sequence or a partial sequence of a gene must be disclosed in the patent application. It is not quite clear how this provision must be interpreted. One option is to see it as a mere repetition of the general patentability requirement of industrial applicability. This interpretation does at first seem less likely since it would be non-sensical: it does not add anything to the normal application of the requirement of industrial applicability. Another interpretation may be that the function of a gene patent should be mentioned in the claims. Then the patent only confers an exclusive right to use the gene for the specified function. The latter interpretation would make for specific law for gene patents. In 2005, the European Commission has evaluated the effect of Article 5(3) of the Directive.³ The Commission indicated that (European Commission 2005):

'as a specific field of technology becomes mature, the application of the normal patent criteria of novelty, inventive step and industrial applicability means that future patents are necessarily limited in scope because the invention claimed has to be distinguished from the vast array of what is already known in the field[11]. As it is now seventeen years since a Directive was first proposed, it may be questionable whether attempting to further refine the scope of protection of gene sequence patents in the light of divergences between national legislations will have any significant effect on actors in the field.'

The Commission indicates that in a relatively short time this piece of special legislation – if at least it is to be interpreted as such - has made itself superfluous. Apparently, purpose-bound patents do not give patentees an effective protection. Patents would become too narrow. What implications does this have for the desirability of specific rules for the industrial applicability of nanotechnology patents? It is likely that also in the case of nanotechnology patents the issuing of overbroad patents is a problem associated with the initial stages of development of the technology. The lack of scientific knowledge and prior art in general makes it difficult to draw a line between broad and overbroad

protection. Any attempt at a solution of what seems to be a recurring problem with any new technology will be handicapped by the same lack of scientific insight in the nascent technology and therefore difficult to implement. The slowly growing scientific insight in the technology points in two directions: on the one hand, it points to a solution later in the technology life cycle when more is known about the technology and its underlying science. On the other hand, it points to more transparency right from the start. Opening up possibilities for revocation of an overbroad patent 'later on' could be an effective intervention. Opposition against a 'European patent' is however limited to just nine months after the grant. In this respect, the advent of a centralised European court system would bring relief. The development of the legal foundations for a European and Community Patent Court has been set in motion (European Commission 2009). Lack of industrial applicability can be a ground for invalidating patents later on in a patent's life cycle, especially if no concrete applications of the patented invention appear. It may however not always be easy to determine whether that is the case. For instance where patented upstream research results can function as research tools, they still may be said to amount to practical applications. This is an argument often raised in biotechnology cases. Furthermore, invalidations later in a patent's lifecycle do run the risk of lessening legal certainty with respect to the validity of granted patents and must therefore be used with care. The other option – working on transparency – may therefore be more fruitful. As indicated above, ensuring that nanotech patents are sufficiently disclosed is important. It is something the courts and the patent office can see to, even without special regulation (Burk & Lemley 2003). A change in the definition of the person skilled in the art can lead to more encompassing disclosure. Also a change in the standard of industrial application – as used by the courts - may result in more exacting indications of the industrial application of the invention in the patent.

Conclusion

According to the European Commission, Europe is not good at transforming nanotechnology research into marketable applications (European Commission 2004, p.7). Thus, while the numbers show that nanotechnology based patents have not reached the high volumes some would have hoped for, patent law is not to blame (Kinsler 2006). It offers enough room to patent nanotechnological inventions. The possibilities for patenting nanotech inventions should be considered positive.

At the same time, nanotechnology has a number of characteristics that raise the risk of over-patenting, such as patents on building blocks of the technology and overlapping patents through inconsistent use of terminology. In this chapter, it is argued that such concerns should be addressed. A number of avenues have been identified for improving the application of the patent law, specifically as it relates to the inherent characteristics of nanotechnology inventions. For instance, a person skilled in the art of nanotechnology should be chosen as a team of not too highly qualified workers in the partaking technologies so that disclosures of inventions become more exacting. Furthermore, patent offices should closely follow work in standardisation of terminology and metrology in nanotechnology and if possible they should participate in standard setting processes in order to lessen ambiguities that complicate the process of patenting. For now, that must result a higher quality of granted patents. At a later stage when applications of nanotechnology are being developed and appear on the market, ways of facilitating the licensing of nanotechnology will also become a relevant

instrument for dealing with innovation in the field of nanotechnology. But that is a future concern ...

¹ The EPO has taken measures to prevent this from happening.

² See T 60/89, OJ 1992, 268, T 694/92, T 187/93 and T 412/93.

³ See Article 16b Directive 98/44/EC.

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