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"Exploring Materials through Patent Information"

By David Segal (Abingdon, Oxfordshire, UK), Royal Society of Chemistry, Cambridge, UK, 2015, 244 pages, ISBN:978-1-78262-112-6, £24.99, €31.24, US$40.00

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The majority of books and reviews on any area of technology development tend to focus on information published in the journal literature; reviews of the patent literature are more often confined to the prior art sections of patent documents. However, patents remain one of the best sources of detailed technical information, particularly where the invention may have commercial significance, and it is good to see this reviewed in a book.

The author, David Segal, is a graduate of Trinity College Cambridge, UK. In his long career he has worked widely in the fields of chemicals and materials and has published a number of patents and papers.

Introduction: Exploring the World of Materials through Patent Information

In Chapter 1 Segal provides a general introduction to the topic of materials for the non-specialist. He makes the point that materials underpin many of the technological advances that we know in everyday life; for example, the use of lanthanide elements as phosphors to generate colour in display screens, or the application of neodymium iron boron (NdFeB) magnets in computer hard drives and magnetic resonance imaging (MRI) scanners. The success of additive layer manufacturing (ALM), also known as additive manufacturing (AM) or 'three-dimensional (3D) printing' technology, depends on the availability of plastics that can be converted into molten droplets and of ceramic and metal powders that can be formulated for use in a range of different ALM techniques.

Chapter 1 also provides a basic introduction to patents, covering 'what is a patent?' and patent structure (front page data, background to the invention, summary of the invention, embodiments, drawings and claims). Sections are included on patent filing, patent infringement and patent searching. The book stresses the importance of seeking specialist advice from qualified practitioners. As with much of the book, however, too many topics are included, making coverage superficial.

Chapters 2–13 review a wide range of emerging technologies in the context of patent information: light emitting diodes, quantum dots, organic light emitting diodes (OLEDs), liquid crystals and liquid crystal displays, ALM or '3D printing', healthcare, block copolymers, aerogels, ionic liquids, flame retardants, graphene, hydrogels and super-hydrophobic materials. I have chosen three of these chapters to review below.

Additive Layer Manufacturing

Chapter 6 is titled '3D Printing'. Segal describes the evolution of this process starting from Swanson and

Kremer's photopolymerisation by computer controlled laser beams. In fused deposition modelling, 3D parts are built up layer-by-layer from a thermoplastic material using a digital representation of the part. In selective layer sintering a layer of metal, ceramic or polymer powder is deposited under computer control and sintered by scanning a laser across the surface. In each case the process is repeated to ultimately form a 3D part. The use of the term '3D printing' was coined later by Sachs *et al*. and used, for example, in their 1993 patent (1).

The chapter goes on to give a number of examples of patents on applications of ALM (**Figure 1**). Aerospace components are discussed, as are dental prostheses and biomedical implants. Among the aerospace examples, Segal describes a high temperature AM process to make titanium near-net-shape metal leading edge protective strips for aerofoils (2). A key feature is heat transfer away from the support mandrel. In the dental field he describes the use of selective laser powder processing to build up a jaw structure from titanium (3). Although Segal reproduces technical details of the laser required to melt the metal particles, he does not discuss the significance of such a process, which in this case is the ability to fabricate complex shapes without lengthy pre- or post-processing and the ability to customise parts to individual patient requirements in the same production run.

Some examples are also given of components needed for ALM machines such as shutter mechanisms and wiper blades.

Organic Light Emitting Diodes

Chapter 4 discusses the development of OLEDs. It starts with a review of the early development of electroluminescence, for example the work by Gurnee and Fernandez which showed that a doped host material with a conjugated structure, such as anthracene, gave off green light when placed between two electrodes (4). Pioneering work by Friend *et al.* on conjugated polymers such as poly(*p*-phenylvinylene) (PPV) formed the basis of polymer light emitting diodes (PLEDs) (5). Later it was discovered that organic phosphorescent materials, which can emit light in the triplet state, are potentially more efficient than fluorescent materials which can emit only in the singlet state. The example is given of the green phosphorescent emitter tris(2-phenylpyridine)iridium, $Ir(ppy)_3$. Of course the phosphorescent emitter layer is only one of a complex series of material layers and the development of complex circuitry is an essential part of the realisation of a working OLED device.

Graphene

Chapter 12 discusses graphene, a material which has received much interest since its discovery in 2004. The development of methods for making it, including wet chemical processes, vapour phase processes, the use of ionic liquids and electrochemical methods, have been key; details of these processes are best found in the patent literature. The chapter goes on to

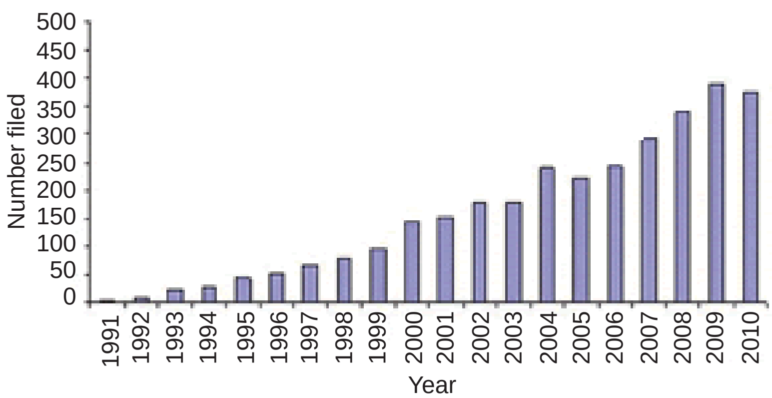


Fig. 1. Filing rates in additive layer manufacturing (Copyright Coller IP)

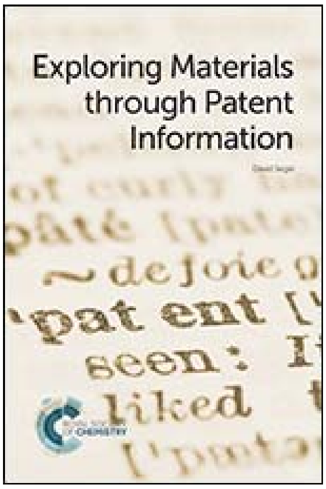
discuss potential methods for large scale production of graphene, essential for successful exploitation; chemical vapour deposition is one such method. Incorporation of graphene flakes into the polymer matrix of a fibre reinforced composite can increase its compressive strength, potentially useful in racquets and other sports equipment. In lithium-ion batteries, multilayer graphene films have been evaluated for use as an anode and graphene platelets have been used to reinforce the matrix of a cathode material.

Conclusion

Overall, the book does effectively make the point that patents contain a wealth of technical information and should be considered alongside journals and other sources when researching a topic. It successfully gives a broad overview of the historical development of each topic, with references in the form of patent numbers which serve as a starting point for further reading. The focus is very much geared to demonstrating the technical detail that can be found, with examples of material compositions and experimental data as claimed in individual patents.

However, this reviewer believes that it tries to cover too much material in too small a volume and as a result does not really do any individual topic full justice. Too many patents are referenced and too much non-essential experimental detail from the patents is included. At the same time, the significance of each invention is often not clear without going back to the original patent source and this detracts from the overall readability.

Segal's book does not touch on how patents have altered the course of development of a technology by impacting different companies' freedom to exploit it; nor does it make any reference to how the existence of patents has affected the commercial development of a technology. In my opinion, such a discussion would have helped to round out a promising but somewhat disappointing volume.



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References

1 E. M. Sachs, J. S. Haggerty, M. J. Cima and P. A. Williams, Massachusetts Institute of Technology, 'Three-dimensional Printing Techniques', *US Patent* 5,204,055; 1993

2 M. W. Peretti and T. Trapp, General Electric Company, 'Methods for Making Near Net Shape Airfoil Leading Edge Protection', *US Patent Appl.* 2011/0,143,042

3 J.-P. Kruth, I. Naert and B. Vandenbroucke, 'Procedure for Design and Production of Implant-based Frameworks for Complex Dental Prostheses', *US Patent Appl*. 2008/0,206,710

4 E. F. Gurnee and R. T. Fernandez, The Dow Chemical Company, 'Organic Electroluminescent Phosphors', *US Patent* 3,172,862; 1965

5 R. H. Friend, J. H. Burroughes and D. D. Bradley, Cambridge Research and Innovation Ltd, Cambridge Capital Management Ltd and Lynxvale Ltd, 'Electroluminescent Devices', *US Patent* 5,247,190; 1993

The Reviewer

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