FINAL REPORT

THE IMPORTANCE OF NICKEL COMPOUNDS:

OPTICAL MEDIA

Prepared for

European Nickel Institute

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1. INTRODUCTION

The Optical Media sector meets the needs of customers for high quality data storage, replication and retrieval. It is an integral part of the entertainment industry (in terms of music, films, and computer games) and the IT industry.

The Optical Media sector encompasses the production and sale of 'software' based on Compact Disc (CD) and Digital Versatile Disc (DVD) technology, and the production and sale of associated hardware, in the form of CD players, DVD players and games consoles. Today, CD and DVD drives are also an integral part of most personal and laptop computers.

The Optical Media industry is underpinned by high precision replication technologies, the most important of which is nickel-based electroforming. CDs and DVDs are produced by injection moulding of polycarbonate resin in a mould. Nickel-based electroforming enables the production of highly accurate moulds, which in turn facilitate very high volume, high quality, accurate replication of CDs and DVDs.

Nickel compounds are critical to the production of moulds.

2. NICKEL AND OPTICAL MEDIA

The nickel electroforming process consists of an electrolyte bath based primarily on nickel sulphamate solution. The nickel sulphamate provides the nickel ions used to deposit nickel onto a conductive patterned surface such as glass or stainless steel. Once the plated material has been built up to the desired thickness, the electroformed part is stripped off of the master substrate.

Nickel sulphamate solutions are widely used for electroforming because of the low internal stress of the deposits, high rates of deposition, and superior throwing power. Throwing power is the relationship between current distribution and uniformity of coating thickness, as influenced by geometric factors (the shape and relative positioning of anode and cathode), and by the electrochemical characteristics of the solution (conductivity, cathode polarization, and cathode efficiency). Throwing power is a measure of the extent to which a solution will produce deposits that are more uniform than those that would be produced in the absence of cathode polarization and cathode efficiency effects. Because of the very high solubility of nickel sulphamate, a higher nickel metal concentration is possible than in other nickel electrolytes, permitting lower operating temperatures and higher plating rates. A small amount of nickel chloride is usually added to nickel sulphamate solutions to minimize anode passivity, especially at high current densities.

Modern applications of nickel electroforming are diverse and today nickel is used in a great variety of different electroforming applications. The reasons for its popularity include the fact that electrodeposited nickel can be strong, tough and resistant to corrosion, erosion and wear. Its mechanical properties can be varied when necessary

by changing plating conditions, by alloying with other elements and incorporating particles and fibers within the electrodeposited nickel matrix.

In the optical media industry, nickel electroforming is the only technique by which extremely precise information present on the original surface such as shallow or micro-indentations on the surface of CDs and DVDs, can be replicated as in the original. All indentations must be of exactly the correct size and shape and in the exact same position on the disc surface if accurate sound and picture production is to be achieved.

3. IMPORTANCE OF OPTICAL MEDIA FOR THE EU

3.1. Economic Impacts

The Optical Media value chain comprises two distinct parts – 'Software' and 'Hardware'. The software value chain encompasses the mould and equipment makers, the CD and DVD pressing companies, and the retailers of music CDs, Film DVDs, and games software. It is estimated that a total of 7 billion CDs, DVDs and Recordable/Recordable optical discs are pressed in the EU each year. This represents 20% of all optical media produced globally, but over 30% of CDs and DVDs used for replication in the entertainment industry (music, films and computer games). Key manufacturers in the pressing industry in Europe include Sonopress (with operations in Germany, France, Spain, Belgium, UK and Ireland), Mediamotion (with operations in the Netherlands, UK, France, Germany and Belgium), and Cinram (with operations in Germany, France and the UK).

Pressing companies supply CDs and DVDs to 'content' producers such as music companies, film companies and games software producers. Many of these are major multinational companies such as EMI (UK), Vivendi Universal (France) and Bertelsmann (Germany), but there are also a large number of smaller companies such as independent music labels, small film production companies and computer games software designers. Music CDs, Film DVDs and Computer games are then sold in Europe through a wide range of retail outlets. Some of these are large specialist retailers such as HMV (UK), Virgin (UK), FNAC (France), World of Music (Germany), Promarkt (Germany), and The Game Group (UK). Supermarkets and hypermarkets are also major retailers of CDs and DVDs in many EU countries as is Amazon, the large internet retailer.

The hardware value chain comprises the manufacturers and retailers of CD players, DVD players, and games consoles. It is estimated that a total of 11 million CD players, 30 million DVD players and 17 million games consoles were sold in Europe in the last year. Whilst many Far Eastern companies are dominant in these markets, some European companies have strong positions such as Philips (The Netherlands) and Bang and Olufsen (Denmark) and Bose (Germany).

Together the software and hardware value chains for optical media are estimated to account for around Euro 40 billion in retail sales. They are estimated to support around 280,000 jobs directly and a further 120,000 indirectly through suppliers and

induced effects in the wider economy: a total of approximately 400,000 jobs. In addition, the optical media sector is estimated to contribute around Euro 16 billion gross value added directly to the EU economy, and a further Euro 6 billion indirectly through suppliers and induced effects in the wider economy; a total of Euro 22 billion in gross value-added.

Moreover, around 53 million Personal Computers and Laptops (worth Euro 42 billion) were sold in Europe last year, the majority of which had an integral CD or DVD drive, reflecting the importance of CDs and DVDs as software and information storage devices within the IT industry. Software sales in Europe amounted to more than Euro 70 billion, a significant proportion of which was delivered using optical media.

Although other technologies are available, optical media technology is likely to remain one of the leading data storage technologies, because of its cost and flexibility.

3.2. Other Impacts

The Optical Media sector also brings other benefits to Europe in terms of efficiency and innovation.

Efficiency – Nickel electroforming technology has enabled the mass production of optical media, cheaply and in large quantities. This, in turn, has revolutionised the storage of data, enabling users to access very large, complex and sophisticated software programmes, films and music tracks, cheaply and efficiently. The unit cost of data storage has fallen dramatically, the accuracy of replication has risen exponentially, whilst flexibility, portability and accessibility have all grown significantly, providing more computer power and entertainment value to consumers at lower cost.

Innovation – Optical Media has also provided the platform technology for vast innovation in both the Entertainment and IT industries. The use of CDs and DVDs has quadrupled over the last five years and is forecast to continue to grow in the foreseeable future, despite the increase in digital downloads. They have provided the degree of precision, robustness, and vast data storage capability needed for the development of ever more sophisticated and innovative software and computer games, and for music and film producers to provider ever-increasing quality, choice, flexibility, control, and user interaction.

4. CONCLUSIONS

The optical media industry has a complex but wide-ranging value-chain encompassing both the entertainment and IT industries, both software and hardware. Together, they have a significant socio-economic impact in Europe in terms of sales, value-added and jobs. But more importantly, optical media is a platform technology that has brought significant benefits to Europe in terms of efficiency and innovation.

The optical media industry, however, is underpinned by electroforming technology, which depends upon nickel compounds.