# MICROELECTRONICS UNDER SOCIALISM[1]

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## 1. INTRODUCTION

Throughout history inter-regional technology transfer has taken place due to the varied levels of technical knowledge and practical skills within aforesaid regions. With the exception of the emigration of workmen, technology transfer has often been illegal, in particular in the military field. This technology theft is still happening in the present day and may be seen at both company and national level. Throughout the Cold War the constant transfer of illegal technology between West and East obtained significance with regard to security and politics. Both NATO and the Warsaw Pact strove to possess technically advanced weapons that would enable the defeat of their opponent, conversely both powers also tried to accumulate information on the level of technology used by their opponents in this arms race to try and gain an edge.

An area of key importance in which the two Super Powers and their allies fought this information battle was the field of microelectronics and computer technology. The technological basis of today's IT was developed in the 1970s and – especially – the 1980s.[2] A decisive event occurred during that period that influenced future IT development: In the Detente period of the 1970s legal trading contacts were formed allowing high tech Western products into the USSR and other COMECON countries.[3] Around 1980 this situation underwent radical change – after being elected, Ronald Reagan tightened the embargo conditions regarding the East. One reason for this change was the movement of Red Army troops into Afghanistan in December 1979 and the threatening intervention of the Soviet Union in Poland after the sharpening of the political situation there. The Reagan Administration considered high technology as an important competitive field in which the USA and the West could easily outpace the East. This consideration was to have far reaching consequences.

With the described tightening of embargo conditions the necessary technology to allow large-scale integration was not available any longer. In the mid 1980s only the USSR and GDR tried to continue their development of a semiconductor industry because only these COMECON countries had the ability to work in semiconductor highest integration.

This paper is focused on these two countries (USSR and GDR) and discusses examples of illegal technology transfer from West to East in the 1980s – a transfer that allowed the production of integrated circuits. At a more global level the first story deals with the flow of high tech equipment for VLSI chip production into the USSR,[4] while the second example tells a more detailed story about the attempted development of a microelectronic industry in the GDR capable of producing VLSl circuits.

## 2. PLAYER IN THE GLOBAL SECRET WAR

In the Soviet Union the transfer of information and technology was controlled by a specific branch of the political leadership (Fig. 1) – this being the Presidency of Soviet Council of Ministers with its Military Industrial Commission (VPK: Voenno-Promyshlennaia kommissiia).[5] The VPK consisted of representatives from the Ministry of Defence and top managers from the Military Industrial Complex and was responsible for coordinating the development of all Soviet armament. Additionally the VPK organised the collection of information about Western technologies – all questions regarding Western knowledge were sorted by priority and then directed to the appropriate acquirement institutions.[6] Other parts of this organisation were the State Committee for Science and Technology, the Academy of Science, the Ministry of Foreign Trade, and other defence manufacturing ministries, the State Committee for Foreign Economic Relation (GKES: Gosudarstvennyi komitet po nauke i tekhnike) as well as the Committee for State Security (KGB) and the Military Secret Service (GRU). Of note is the fact that within KGB Department T more than 500 scientifically and technologically trained employees worked on the conspirative acquisition of technology. This acquisition was facilitated by a worldwide network of employees who worked as diplomats, traders, and journalists inside embassies, consulates, trading offices, and branches of Soviet state companies. The GRU also had its own operational science and technology section, which dealt largely with armament technologies. The Soviet secret services worked – like any other secret service – using a combination of both covert and overt methods and also had the support and assistance of Eastern European secret services. In conclusion, it is obvious that stealing Western technology was, without doubt, a political decision.

Immediately after World War II, Western secret services began to monitor the activities of their Eastern counterparts as a process that continued for the duration of the Cold War period. Following pressure from the Reagan Administration the COCOM[8] list was tightened at the beginning of the 1980s. In the USA specialist new departments were created to combat illegal technology transfer: at the CIA the 'Technology Transfer Intelligence Committee', and at the Department of Defence the 'Technology Security Administration' came into being. The US Department of Trade increased the number of its investigation personnel and the US Customs formed the special group 'Operation Exodus'.[9]

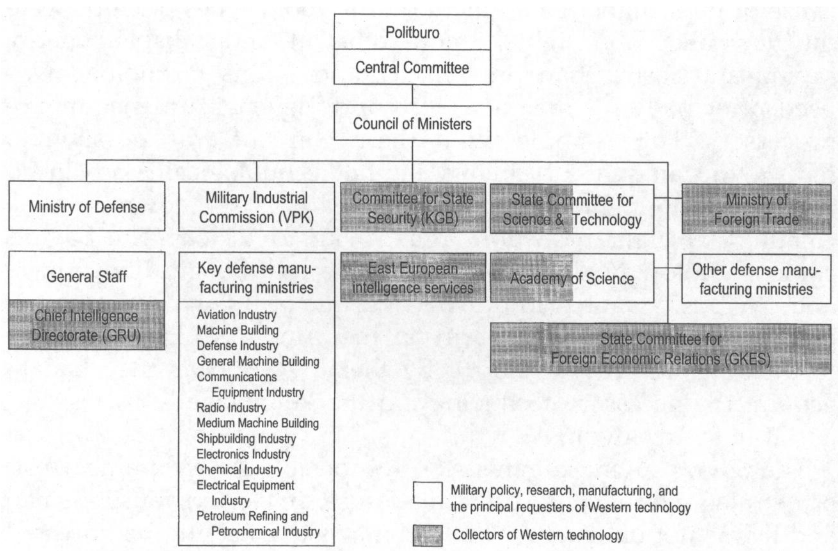


**Figure 1:** Organisation of transfer of knowledge and technology into the Soviet Union[7]

## 3. PROCUREMENT OF EQUIPMENT FOR CHIP PRODUCTION IN USSR

Global interest in microelectronics took off in the 1970s and 1980s and this interest was as evident in the USSR as anywhere else. The Soviet Union and other COMECOM countries were able to legally procure a huge amount of integrated circuitry on the world market – by the end of the 1980s 100 Million chips came into the Soviet Union annually by official means. In addition to this prior to 1980 the USSR had legally bought several hundred tons of highly purified silicon, mainly from the USA, the Federal Republic of Germany (FRG), and from Japan. This material allowed the domestic production of circuits within Soviet industry, however, due to the tightening of the COCOM list in the early 1980s the sale of silicon was prohibited causing the Soviets to procure this essential commodity by illegal methods.

However, the key issue of this technology transfer laid in production machines and equipment – an excellent example of this is given with the VLSI (Very Large Scale Integrated) and the VHSIC (Very High Speed Integrated Circuits) technology.[10] Because of their higher component density both types of chips were much smaller and lighter, more efficient and reliable, energy saving and faster than previous circuits – this technology was used principally for memory chips and high performance microprocessors. For example, with these chips it was possible to reduce the amount of circuits in the technologically advanced American F15 fighter aircraft from nearly 5,000 down to 40 – creating a weight reduction from 25 kg to 1.5 kg. The Soviets could not allow NATO to possess such a technological advantage and obviously wanted to possess and mirror this type of technology in order to maintain parity in the arms race. However, due to their inability to develop it by their own means they had to acquire the necessary technology in the West, legally if possible, and if not – by spying.

The Soviet spying organisation responsible for obtaining Western strategic technology often made use of Western businessmen and it was not unusual for these contacts to exist and be nurtured over many years. At first the business of acquisition had been legal but as the percentage of profit increased for the businessmen as well as did the degree of illegal technology transfer. An example of this type of illegal business with computers and technological equipment for chip production is provided by the so-called Mueller affair.[11] The FRG citizen Richard Mueller possessed around one hundred companies worldwide and at the beginning of the 1980s he accumulated high tech devices – mainly VHSIC production technology – to a value of 8 million US Dollars for his Soviet partners – all bought through his network of companies. But his smuggling was soon discovered: In November 1982 a Swedish transport ship carrying prohibited technology was scheduled to move from Cape Town (South Africa) via Hamburg (FRG) and Helsingborg (Sweden) to Moscow. But in Hamburg custom officers of FRG and USA stormed the ship and three containers full of embargoed goods were taken ashore – in Helsingborg another four containers were confiscated. This bounty was presented a short time later by US Secretary of Defence Caspar Weinberger at a press conference in Washington. The worldwide investigation into the Mueller affair had cost 1.2 million US Dollars and involved the governments in Washington, Bonn, and Stockholm. Despite the international profile of this case it ended in a less spectacular manner at the District Court in Luebeck (FRG). Because of the disappearance of Mueller only three of his employees were convicted.

But not only dubious individuals dealt with embargoed equipment. For example, due to the involvement of one of its European branches in the Mueller affair, the US computer company Digital Equipment Corporation (DEC) had to pay a fine of 1.2 million US Dollars in order not to lose its US export license. Other Western companies were less 'noisily' involved, e.g. the Swedish company Data Saab voluntarily paid one million US Dollars to prevent itself being placed on the blacklist.

Autumn 1982 saw the defection of a KGB General to France and this shed light on exactly how widespread illegal technology transfer had become. The General brought with him 4000 top-secret documents, several of them carrying handwritten notices from the Soviet party leader Leonid Brezhnev.[12] The evaluation of this material took over three years and after analysis was complete it was evident that during the 10th Five Year Plan (1976 to 1980) over 3500 strategically developed devices were smuggled from the West into the USSR. By all accounts this saved the Warsaw Pact arms industry up to 2.24 Billion US Dollars in development costs.[13]

After this disclosure the US administration put massive pressure on neutral states such as Austria, Switzerland, and Sweden to increase the embargo protection and to follow perpetrators more intensively – this pressure was reinforced when American specialists travelled to the European capitals to push for action. Western secret services went as far as founding their own dummy firms to study the ways and methods in which high technology equipment could be delivered beyond the Iron Curtain. Whole networks of informants observed airports and suspicious transport companies and the US Customs special group 'Operation Exodus' supported their European colleagues in raids should intelligence pay off.

Subsequently the number of high technology deliveries into the Soviet Union decreased and prices climbed drastically. Around 1985 the Soviets had adjusted to this new situation and while it had become more difficult to use Western high tech smugglers in the neutral countries of Austria, Switzerland, and Sweden, the operations were moved to the Mediterranean countries, the Far East and the Third World. Furthermore the Soviet secret services recruited help from their counterparts in Hungary, Poland, Czechoslovakia, Bulgaria, and GDR. An example of this shift in focus away from Europe is shown in the spring of 1985 – on a route passing through Malta, Cyprus, Istanbul, and Thessalonica several VAX 780 computers, camouflaged as office machinery, found their way to the Bulgarian capital Sofia. The FRG citizen Walter Bruchhausen was responsible for this operation – he was subsequently arrested in 1985 in London and in May 1987 was sentenced by the Federal Court of Los Angeles (USA) to 15 years prison and was additionally fined the sum of 15,000 US Dollars. Bruchhausen explained his acts as support for the policy of détente represented in particular by the FRG foreign secretary Hans-Dietrich Genscher.[14]

The cases that were discovered showed the enormous degree of Soviet technological espionage. But only the opening of Russian archives pertaining to the period will allow the full extent of this technical espionage to be understood. One may confidently assume that all desired technical equipment was available in USSR – although probably not at the exact time required and unlikely to be in the desired quantity.

## 4. MICROELECTRONICS MADE IN GDR

In contrast to the Soviet Union the GDR was poor in terms of raw materials and had to sell industrial products on the world market – traditionally, the GDR offered tool press, textile, polygraphic, and other industrial machines. However, as technology advanced Western companies demanded modern control equipment and for that reason the GDR had to buy Western control components – thereby diminishing its profits enormously. In reaction to this the GDR political leadership tried to develop a separate microelectronics industry: Guenter Mittag, Central Committee Secretary for Economics of SED,[15] wanted to use microelectronics as a platform to allow a technological revolution within the GDR – thereby creating conditions that would allow the GDR to overcome the permanently increasing economic crises of the 1980s. High technology was seen as an aid to assist the stabilisation of the political system in GDR with regard to both economics and ideology.[16] The difficulties involved in implementing this plan increased when it became evident that GDR could not hope for help from the Soviet Union or other COMECON countries. Soviet success in microelectronics was limited to the military industrial complex rather than the trade sector and for security reasons the USSR did not deliver any information about this 'closed field'. In the instances when Soviet equipment was received by the GDR microelectronics industry, it became obvious that these machines could produce integrated circuits but not in an economic manner.
In this 'hopeless' situation the GDR leadership decided to develop its own microelectronic industry. The scale of this task is made evident by an SED internal analysis at the end of the 1970s showing that the East German semiconductor technology lagged behind most developed countries. For analogue ICs the gap was between four and eight years, for digital semiconductors and microprocessors six to seven years, and for special technological equipment up to nine years. The productivity of the equipment was a tenth, or in the best case a third, of that in the West but the costs were as high as five times more.[18] Although the internal circle of the Central Committee was aware of the enormity of this challenge, it believed in 1977 that an accelerated extension of the microelectronics industry of the GDR would be possible. At that time the SED strategists believed that it would be possible to

| | | GDR-introduction | | | International introduction |
|---|---|---|---|---|---|
| Level of technology | Type of dRAM | Research sample | Lab sample | Mass production | Mass production |
| 3 | 64 kilobit | 1981 | 1986 | 1988 | 1979/1980 |
| 4 | 256 kilobit | 1987 | 1988 | 1990 | 1983 |
| 5 | 1 megabit | 1988 | 1989 | planned 1992 | 1986/1987 |
| 6 | 4 megabit | planned 1991 | planned 1993 | planned 1994/95 | 1989/1990 |
| 7 | 16 megabit | 1994 | – | – | 1993/1994 |
| 8 | 64 megabit | 1996 | – | – | 1997/1998 |

**Figure 2:** International state of development and forecast of high integration according to an internal SED paper of 1989[17]

organise a real and good cooperation within COMECON. However, they seriously underestimated the effects of the US embargo policy and overestimated the opportunities and abilities of the GDR secret service to acquire special equipment in defiance of the embargo.

The idea of 'microelectronic made in GDR' became more and more problematic – one reason was the permanent lack of foreign currency and another being the increasing US embargo policy. Nevertheless, GDR industry needed technological equipment and – similar to the USSR – a special branch of their secret service was created with the mission of getting the necessary equipment. This practice created further specific difficulties. For example, only secret service members could negotiate with Western businessmen and their technological knowledge was often less than ideal. This lack of specialist knowledge at 'the coal face' led to the purchase of the wrong kind of equipment or failure to meet purchase deadlines. Additionally, for protection of the country of origin and manufacturer of the machines they had to be 'neutralised'. That meant all hints showing the original producer or the way by which they had come into the GDR had to be erased, this concerned not only name or type plates but also all manuals – the problems with this degree of sanitisation are obvious.

Although highly qualified staff worked in the research laboratories on high technology equipment, most of the memory ICs were replicas of Western variants. For that reason, no development process could be started without having at least one Western chip. Often it was impossible to buy a single chip in isolation and therefore it was frequently necessary to procure an expensive machine that contained the specific chip. After removing the chip, the logic was analysed. The following development of that technology meant to find a way to mass-produce it with technological equipment then existing within GDR factories. But with memory ICs approaching megabit capacity miniaturisation reached such a level that replication was more expensive than developing it oneself.

Of course Western competitors knew of this practice. For example a GDR chip analyst once read the following sentence in Russian on a processor chip from the US firm Digital Corporation: 'When do you want to stop to swipe. Own design is better.' (Fig. 3).[19]

With increasing component density the replication of a chip took too much time and GDR tried to obtain licenses.[20] Although the embargo regulations did not allow official license transactions the GDR found secret license givers, for example, the Japanese company Toshiba. But in order to protect Toshiba, the production process for the 64-kilobit dRAM had to be modified. This led to production complications in the Thuringian high tech city Erfurt – despite the fact that Toshiba had made the complete documentation of the modified circuit available.After the settlement of the economic conflict between Japan and the USA in July 1986 Toshiba had to break off its relations with the Erfurt factory. This led to the following secret service story that occurred on a refuse dump near Erfurt. There, in July 1988, German and Japanese individuals met to witness the destruction of all documentation and masks for chip production (as demanded by Toshiba) – of note is the fact that only replicas, not originals were destroyed. The aftermath of this collapse of technological relations caused the realisation among the GDR leadership that it would now be impossible to obtain a license from Toshiba for 256-kilobit memory circuits.

Despite the technical time lag in comparison to the most developed industrial countries in the West, East Germany was one of the few countries in the world actually working in this field. Therefore to make the most of their technology the concept was raised to sell this technology to less developed countries. A top-secret paper from December 1988 mentioned the following countries as partners with substantial interests in factories or laboratories: Poland, Brazil, USSR, Czechoslovakia, and China as well as enquiries from India, Iran, and Scandinavia. However, the project failed because it was vetoed by the secret service. If the GDR had had to deliver complete factories or laboratories that contained components which were not produced in COMECON and which were possessed and utilised only after circumventing the US embargo, this would reveal the deficiencies within the GDR microelectronic development industry – not to mention industrial espionage. The GDR secret service, like any other, did what was necessary to keep its activities secret.[22]

At the same time GDR tried to develop technology for the future. With the support of Western companies, e.g. the Austrian company Sacher Technik Vienna, scientists at the Dresden re-

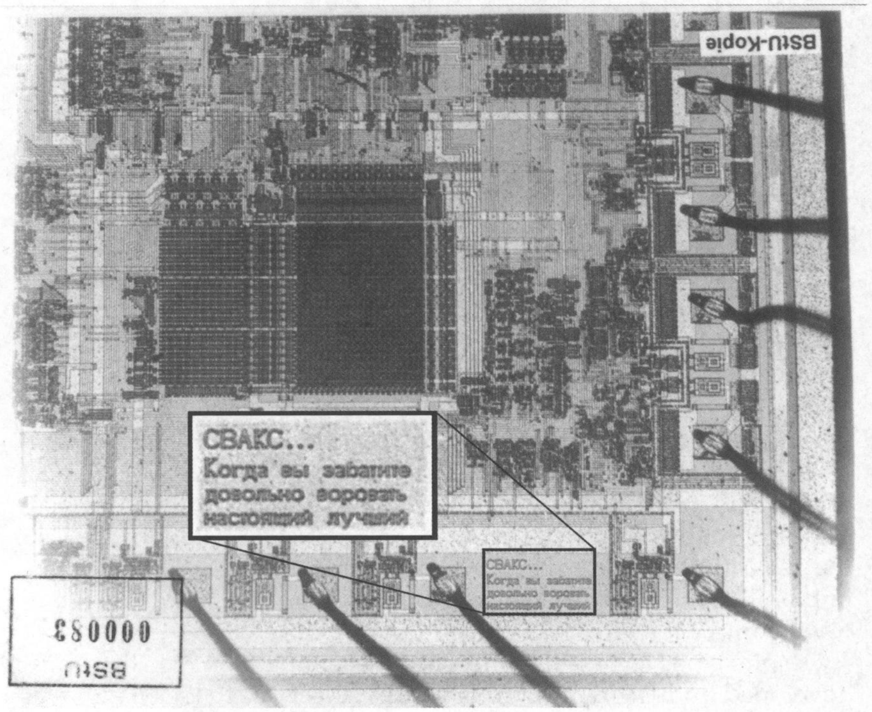


**Figure 3:** Part of the aluminium layer of a chip by the company Digital Corporation[21]

search centre and at the high tech company Carl Zeiss Jena worked on ion beam lithography. These activities could not help to preserve GDR, but it served a good starting position to high tech part of Carl Zeiss Company after unification in 1990.[23]

## 5. SUMMARY

The great effort to maintain the strategic balance during the Cold War created the circumstances to require illegal technology transfer. The main difference between the two cited examples (microelectronics in the USSR and in the GDR) is as follows – the Soviet Union stressed the importance of technology for use in the arms race with NATO, whereas the GDR tried to use technology to overcome its national economic crises in the 1980s. Additionally, technology transfer by legal or illegal means led directly to the following point: After the end of the Cold War there were few differences in the depth of knowledge of information technology between East and West due to the simple fact that Eastern specialists used computers and programs similar or even equal to Western ones – and had done so for years. That meant that while the Western computer industry set the global standards with its products and innovations; trading companies, Eastern secret services, Western high tech smugglers and others involved in technology transfer allowed the creation of a 'level playing field' where all specialists, regardless of origin, used essentially the same technology.

### NOTES

1. This paper is a revised presentation of the symposia 'Technology Transfer and Globalization' organised by Alexandre Herlea and Wolfhard Weber hold on the XXI International Congress of History of Science, Mexico City, July 2001.
2. 1948: John Bardeen, Walter H. Brattain and William Shockley (Bell Comp.) discovered the transistor effect; 1958: Jack Kilby (Texas Instruments) and Robert Noyce (Fairchild) created independently the integrated circuit; 1971: Intel introduced the first 4 bit microprocessor Intel 4004 (2.300 transistors), 1972: 1 kilobit memory chip Intel 1103; 1972: 8 bit microprocessor Intel 8008 (3.600 transistors); 1976: 16 bit microprocessor TMS 9900 (Texas Instruments); 1982: 32 bit microprocessor iAPX 432 (Intel, 200.000 transistors), 1985: 1 megabit memory chip; see e.g.: Noyce, R.N.; Hoff, M.E., A., History of Microprocessor Development at Intel, in: IEEE Micro Feb. 1981, pp. 8–21; Malone, M.S., The Microprocessor: A Biography. New York 1995.
3. COMECON: Council for Mutual Economic Assistance; 1949 founded as an economic organisation of Eastern European countries, 1991 dissolved. Brine, J., Comecon: the rise and fall of an international socialist organization. Oxford 1992.

4. VLSI (Very Large Scale Integrated) describes memory circuits with a capability up to 1 megabit or 32-bit microprocessors, meaning a component density between 10,000 to 1 Mill. transistors on a chip.
5. Soviet Acquisition of Western Technology. U.S. Government PB 82–213083. Washington DC, April 1982; Soviet Acquisition of Militarily Significant Western Technology: An Update. Springfield Va. 1985; Alexander, A., Soviet science and weapon acquisition. Santa Monica Ca. 1982 (R-2942-NAS).
6. For examples see: Technology transfer: Soviet acquisition of technology via scientific travel. Selected papers with analysis. Delphic Associates, Falls Church Va. 1991.
7. Soviet Acquisition of Militarily Significant Western Technology: An Update. Springfield Va. 1985; p. 3.
8. COCOM (Coordinating Committee for Multilateral Export Control), founded in 1949, was a voluntary consolidation of all NATO countries and Japan to control and observe exports of military and strategic importance. Mastanduno, M., Economic containment: CoCom and the politics of East-West trade. Ithaca 1992.
9. Tuck, J.; Liebl, K. (Ed.), Direktorat T. Heidelberg 1988, p. 20 and p. 37 footnote 1.
10. Ibid. pp. 18–38, see also Tuck, J., High-Tech Espionage. New York 1986.
11. Paine, L., Silicon Spies. New York 1986, pp. 63–70.
12. Leonid Ilich Brezhnev (1906–1982), 1966–1982 General Secretary of the Soviet Communist Party and 1977–1982 President of the USSR.
13. For details see: Hanson, Ph.: Soviet Industrial Espionage. In: Bulletin of the Atomic Scientists April 1987, pp. 22–29.
14. Tuck, J.; Liebl, K. (Ed.), Direktorat T. Heidelberg 1988, pp. 20–37.
15. SED: Sozialistiche Einheitspartei Deutschland (Socialist Unity Party of Germany), leading Communist Party in the GDR.
16. A very good overview is given in: Barkleit, G., Mikroelektronik in der DDR. SED, Staatsapparat und Staatssicherheit im Wettstreit der Systeme, Dresden 2000; see also: Macrakis, K., Espionage and Technology Transfer in the Quest for Scientific-Technical Prowess, in: Macrakis, K.; Hoffmann, D., (Ed.), Science under Socialism. Cambridge Mass., London 1999, pp. 82–121; Strokes, R.G., Contructing Socialism. Technology and Change in East Germany 1945–1990. Baltimore 2000, pp. 93–109, pp. 161–176.
17. Buthmann, R., Kadersicherung im Kombinat VEB Carl Zeiss Jena. Die Staatssicherheit und das Scheitern des Mikroelektronikprogramms, Berlin 1997, p. 28.
18. Müller, G., Die Politik der SED zur Herausbildung und Entwicklung der Mikroelektronikindustrie der DDR im Rahmen der oekonomischen Strategie zur Durchsetzung der intensiv erweiterten Reproduktion (1976 bis 1985), Akademie für Gesellschaftswissenschaften beim ZK der SED, Dissertation B (PhD) 1989, p. 15.
19. Barkleit, G., Mikroelektronik in der DDR, Dresden 2000, p. 33.
20. Macrakis, K., Espionage and Technology Transfer in the Quest for Scientific-Technical Prowess . . . pp. 113–117.
21. BstU, Aussenstelle Erfurt, Abt.XVIII, Nr.13, Bl. 70, The author wishes to thank Gerhard Barkleit, Dresden, for his references and these picture.
22. Barkleit, G., Mikroelektronik in der DDR, Dresden 2000, p. 113–116.
23. Kaschlik, K., Microlithography in the Eastern Bloc, in: Solid State Technology May 1991, pp. 117–125.