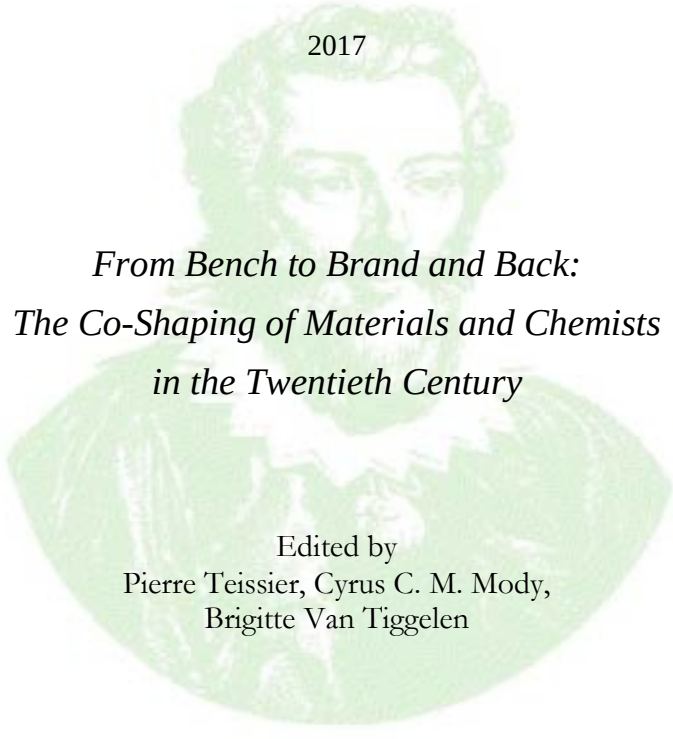
CAHIERS
FRANÇOIS VIÈTE

Série III – N° 2

2017



From Bench to Brand and Back: The Co-Shaping of Materials and Chemists in the Twentieth Century

Edited by
Pierre Teissier, Cyrus C. M. Mody,
Brigitte Van Tiggelen

Centre François Viète
Épistémologie, histoire des sciences et des techniques
Université de Nantes - Université de Bretagne Occidentale

Imprimerie Centrale de l'Université de Nantes
Juin 2017

Cahiers François Viète

La revue du *Centre François Viète*
Épistémologie, Histoire des Sciences et des Techniques
EA 1161, Université de Nantes - Université de Bretagne Occidentale
ISSN 1297-9112

cahiers-francois-viete@univ-nantes.fr
www.cfv.univ-nantes.fr

Depuis 1999, les *Cahiers François Viète* publient des articles originaux, en français ou en anglais, d'épistémologie et d'histoire des sciences et des techniques. Les *Cahiers François Viète* se sont dotés d'un comité de lecture international depuis 2016.

ISBN 978-2-86939-244-3

CONTENTS

Cahiers François Viète, série III, 2, 2017, p. 155-181

Making Sense of Chemistry: Synthetic Rubber in German Popular Scientific Literature (1929-2009)

Jens Soentgen*

Abstract

The chapter analyzes the popular literature on synthetic rubber between 1929 and 2009 and asks how popular science books explained and interpreted rubber research and development to a general (German) public. How does popular literature produce different narratives, including myths, of the same history? The invention and use of synthetic rubber were important topics in popular science literature in the Weimar Republic and during the Nazi period as well as after 1945 in the German Democratic Republic (DDR) and in the Federal Republic of Germany (BRD). Narratives and argumentative schemes of these books are analyzed, and it is shown how they constructed the social meaning of rubber and how the positive and negative resonance of this construction changed according to different political contexts.

Keywords: natural and synthetic rubber, Buna, substance histories, polymer chemistry, Nazi-period, Auschwitz, popular science, history of chemistry, myths of science.

Résumé

Ce chapitre analyse la littérature populaire sur le caoutchouc synthétique entre 1929 et 2009 et questionne la façon dont les livres de science populaire expliquent et interprètent la recherche et le développement sur le caoutchouc à un public généraliste allemand. Comment la littérature populaire produit-elle différents récits, notamment des mythes, d'une même histoire ? L'invention et l'utilisation du caoutchouc synthétique furent des sujets importants dans la République de Weimar et durant la période nazie ainsi qu'après 1945 en République démocratique allemande (DDR) et en République fédérale d'Allemagne (BRD). L'analyse des récits et schémas argumentatifs de ces livres montre comment ils construisent la signification sociale du caoutchouc, qui change de résonance, positive ou négative, en fonction du contexte politique.

Mots-clés : caoutchouc naturel et synthétique, Buna, histoire des substances, chimie des polymères, période nazie, Auschwitz, science populaire, histoire de la chimie, mythes de la science.

* Environmental Science Center, University of Augsburg, Germany.

ALTHOUGH synthetic rubber was produced on a small scale for research purposes in 1909, its social life did not begin before 1915. The first large-scale industrial production of synthetic rubber took place in Elberfeld (today a city suburb of Wuppertal, Germany), then (after 1916) in Leverkusen.

The following study investigates political narratives centering on this extendable substance. In the first place, popular non-fiction books will be evaluated. These contain what the science philosopher Ludwik Fleck (1980, p. 149-150) called exoteric knowledge, i.e., knowledge which is simple and convincing, not as complex as the expert's knowledge: "Out of the expert's (esoteric) knowledge arises the popular (exoteric). It appears thanks to the simplification, vividness and apodicticness certain, well-rounded, solid. It forms the specific public opinion and the world view and in this form reflects back onto the expert." For Fleck this popular knowledge is embodied above all in "popular books", against which he contrasts "textbooks". Popular science books have been a theme several times in science studies (Bell & Turney, 2014; Bertschik, 2008). Authors of such books are sometimes scientists, more often writers or journalists (often with a scientific training). These authors are not to be seen as creative inventors of completely new ways to think or write or act. They try to approximate with their narrations the attitudes, mindsets, values, world-views of the readers and thus to foster acceptance and demand for their book. Readers always include professionals and scientists, but the group of readers is much larger. Popular science books reach thousands, sometimes hundreds of thousands of readers. They are mostly seen as non-fiction literature, however most of these books include fictional literary strategies known from novels or even science-fiction literature. With these, the author tries to entertain his readers. He has to model his personalities also according to the expectations and according to the value system of the readers, in order for his story to reach acceptance.

Popular science books are important for science itself: without popular scientific books that he and others wrote, Einstein's relativity theory would hardly have become a societal event because not many people outside of the scientific community would have taken notice of this theory. Darwin's theory would also have hardly been socially influential without popular books. Popular science books put into perspective scientific research and research results for the greater scientific as well as non-scientific public. They give science a meaning, in the framework of stories, that also reflects back on the scientists themselves, as Fleck (1980, p. 149) already noted. They have at least an indirect impact on the course of science, because they attract young people and encourage (or discourage) them to be-

come scientists. They legitimate or de-legitimate scientific work and thereby influence the funding which society spends on science.

Popular scientific books are a space of transaction between the general public and science. Through them certain areas of science – or also science as a whole – are presented and are religiously, culturally, and politically positioned. My aim in this paper is to describe the mode in which this is done. How do these popular books make sense of rubber-synthesis and rubber-chemistry? Alongside this basic question more technical questions are also to be answered: What is told, and what remains untold in the popular literature? How is rubber-chemistry described and put into political and cultural perspective in the different Germanies that existed in the time-period analyzed?

As I have already explained what I mean by popular books, it remains to discuss the other central concepts that are important for my paper: discourse, narrative, chronicle. By narrative I mean a narration which integrates (struggling) persons, groups of persons, situations, events, and things and which is written or told with the intention to entertain and to inform the reader or the audience. A chronicle is a written sequence of events. Discourse has to be explained a bit more thoroughly. Popular books on certain sciences (chemistry) or on certain scientific achievements are not isolated productions; rather, they form a discourse, a side-discourse to the scientific discourse. They react critically or affirmatively on each other, use the same *topoi*, i.e. the same narrative and argumentative schemes, because the authors of popular books on synthetic rubber read other popular books. But they are not only discourses in the sense of the linguistic discourse analysis, but also in the stronger political and epistemological sense which Foucault inaugurated (Foucault, 1981, p. 74). They create a certain perspective on the historical situation and the role that science plays within it. They attribute a certain political sense to the work of a certain group of people. They have also an economic impact. However, they should be distinguished from mere economic advertising which may be intended to create brands.

The discourse of the popular science books on rubber which analyzed here is a part of the more general public discourse on chemistry and industry. There is lot of evidence that chemistry was already perceived in the German Reich, but especially from the Weimar Republic on, as the most modern and most fascinating natural science, though certain critical accounts were already published (Woker, 1925). This public appreciation of chemistry reached its absolute climax in the "Third Reich". Schenzinger's novel *Anilin* was the most successful novel in Germany in the Nazi-period. After WWII, industrial chemistry, although deeply involved in the Holo-

caust, was still highly esteemed: as highly in the Federal Republic of Germany as in the German Democratic Republic.

This discourse is not only linguistically, but also politically nation-focused. Science – in this case, rubber-chemistry – was related to Germany, but not to an isolated Germany. Germany and German science were seen in a European, transatlantic, and colonial context. However, as already mentioned, there were many Germanys in the time-period that I will analyze: The German Empire (1871-1918), the Weimar Republic (1918-1933), Nazi-Germany (1933-1945), and then the Federal Republic of Germany (since 1949) in the West and the German Democratic Republic (1949-1990) in the East. Synthetic rubber was produced in all of these states, and books on synthetic rubber have been written since the Weimar Republic. That makes an analysis of popular rubber-literature even more intriguing. I collected a corpus of 28 popular German books which deal, sometimes only within a single chapter, with synthetic rubber. The criterion whether or not to include a book in the corpus was that it signaled explicitly or indirectly (by its style, through the use of pictures, absence of scientific details etc.), that it was written for the general reader, not for a limited audience of, say, rubber scientists. The search for these books could not use a systematic method but had to proceed by means of serendipity. Books that had been translated into German were not included systematically. However, these books were also collected and have been taken into consideration, as they influenced the German literature. Thus, the popular books on "red rubber" and the "congo-state" by Arthur Conan Doyle, Edmund Dene Morel and others which were translated into German before WWI proved to be important for the German literature on synthetic rubber.

The analysis of the corpus[1] exhibits ruptures and continuities of discourses during the 20th century. On the one hand, the deep political changes induced several narrative changes in the popular literature on synthetic rubber. On the other hand, there are two striking continuities in the industrial production of rubber in Germany and the hero-making of rubber chemists during the whole period.

Popular books on science always present narrations. A narration not only deals with processes, but also with the actions of people who have characters, friends, and foes. These are modeled according to the values of the either imagined or factual readers of the book. The narrative often follows a certain scheme, for example the "hero saves his people". Especially through the narratives, and somewhat less through arguments, figures, and

[1] Not all of the collected books are quoted in this paper. The author will provide the full list of his corpus on request.

facts, the authors of these books try to 'make sense of rubber-chemistry'. This sense-making means that ideas, experiments, inventions, and industrial activities are integrated into a greater context. They receive a political and cultural significance. They tell the readers something about the meaning of the enigmatic activities of the chemists in the laboratory. Such sense-making would not be successful if it were a mere construction. It uses historical facts, but it combines them in a way that would not be the way a rubber-historian would deal with these facts. They are combined in order to produce a certain emotion, a certain attitude towards chemistry. In the literature investigated here, this attitude is positive. The popular rubber-literature in Nazi-Germany in particular shows this, in that the chemist is stylized as hero and liberator. It is suggested that with his hard, lonely laboratory actions he wants to serve world peace, understanding among peoples, and universal justice. Chemists and rubber chemistry are presented in this manner in the works of Anton Zischka, Karl Fischer and others in the 1930s and 1940s as well as later.

The popular discourse on synthetic rubber in Germany must be distinguished not only from rubber-science itself, but also from the professional historical discourse on the rubber industry. Although the popular rubber books also deal with history, they deal with it in a quite different way than historians of economy or technology or science do. The presentation is much more emotional and does not aim at answering historical questions, but aims at creating motivating images and emotions.

In order to understand exactly why German synthetic rubber – made out of the materials coal and limestone, which are both available in Germany – achieved national importance, the first half of this paper will be devoted to orienting rubber on the political and historical map. We need at least a short chronicle of rubber and rubber-chemistry, a short table of events with the least interpretation possible. Without such a table, it is not possible to interpret the popular rubber literature properly. The following can be seen in this sense as a contribution to a cultural and political history of science.

A Short Historical Chronicle of German Rubber

- *The Colonial Context of Natural Rubber*

Produced from the milky sap (latex) of specific tropical plants, caoutchuc was already known in the cultures of South and Central America long before the arrival of the Europeans. As Las Casas reports, Christopher Columbus brought such a (caoutchuc) ball, as "large as a jug", from the

New World to Seville. This ball was the very first caoutchuc product that reached the soil of the Old World.[2]

At first only the indigenous peoples, who had access to the latex sap and knew how to process it, had a quasi-monopoly on the material because back then the milky sap as such did not transport well from America to Europe. Only the goods that the Indians made in a complicated process that included a biological vulcanization were traded, not the latex sap itself. The discovery of the possibility to make rubber shoes and rubber flasks plastic again and to form and to make the product preservable with sulphur enabled the build-up of a European and American rubber industry.

As natural rubber, *caoutchuc, India rubber, gum-elastic, borracha, hule* and under some other names from the middle of the 19th century, caoutchuc rapidly spread to all of Europe and worldwide. At first primarily used for watertight shoes and coats, it soon served mobilization: In 1888 John Boyd Dunlop developed an air-filled rubber tube for bicycles and later for the manufacture of automobile tires (by Michelin, 1894). Natural rubber was also indispensable as an insulator for the developing electric industry. Rubber became a key substance of the industrial revolution.

Although latex-producing plants and trees also occurred in the Old World, the *Hevea braziliensis*, which primarily grows in the Amazon region, provides an especially valuable caoutchuc in ample quantity. The most important route of the rubber thus went from the upper Amazon via Manaus to Belem-do-Para and; from there over the Atlantic. The flow of rubber corresponded to a flow of money in the reverse direction which made some people in jungle cities, above all Manaus, rich for a short time.

- *Brand Materials of the German Industry: Buna-S and Buna-N*

The monopoly position of Brazil was uncomfortable for the industrial nations which were increasingly dependent on rubber (especially because of the rise of automobile-industry). In 1876 the English planter Henry Wickham secretly shipped to England a huge number of seeds of the *Hevea braziliensis* which had been collected for him by indigenous tribes (Jackson, 2008, p. 288). They were raised there and later shipped to tropical colonies of the United Kingdom. From 1889, caoutchuc also came from the British and Dutch colonies in Southeast Asia, whereby the monopoly position of Brazil as a supplier of pure natural rubber was ended.

Other industrial countries without colonies could either buy rubber on the world market or produce caoutchuc artificially out of other, more

[2] For one history of caoutchuc, see (Soentgen, 2013), which provide extensive literature/references.

easily accessible substances. Although the molecular structure of caoutchuc was unknown at the beginning of the 20th century, several countries found ways to produce synthetic types of rubber. In the Soviet Union, synthetic caoutchuc was produced out of ethanol, according to a recipe of the chemist Sergej Lebedev; the spirits were produced rom potatoes (Lewis, 1979; Plumpe, 1990, p. 355). The US stockpiled huge rubber reserves and later produced synthetic rubber out of oil (Morris, 1989; Plumpe, 1990, p. 355). In the conflict-rich era of imperialism, marked by competition among the great powers, one did not necessarily want the energetically best synthesis or the synthesis that was technically the most elegant, but rather one that could not be blocked by other powers. Therefore, the Germans chose coal and lime as starting materials, because they were certain to have enough of these in their own country. Fritz Hofmann (1936, p. 424), the inventor of the first German synthetic rubber, emphasized this in his 1936 retrospective:

> "From raw materials, which in any amount at any time sufficiently cheap stand at our disposal, we had to proceed if we wanted to come closer to our goal. Of such raw materials in our zone we do not have many. The potato scarcity in the World War has shown us, that even this in normal times abundantly available fruit for the purpose of nourishing animals and people, will be completely claimed if our borders are threatened or even blockaded. But exactly in this situation we must have caoutchuc freely at our disposal. Therefore we have not, as Russia did this, built up our butadiene out of potato spirits, although we knew this route for a long time, but rather we have stayed with coal, of which for many generations forth the most abundant amounts are available." (Hofmann, 1936, p. 424)[3]

German synthetic rubber takes its place in a long line of substitutions and syntheses through which since the 19th century Germany achieved increasing independence from imports from colonial powers and transformed from a dependent recipient of colonial commodities (which foreign colonial powers produced) to an export nation. Beet sugar, camphor, indigo and other dyes, vanillin, ammonia and with it nitric acid and saltpetre (Plumpe, 1990, p. 203-243) – they were all expensive trade goods that had to be imported until, thanks to chemical research, they were henceforth produced in the country itself and exported. During WWI, the Haber-Bosch process, delivering reactive nitrogen, was particularly decisive for maintaining the German battlefront, which would otherwise have broken down from lack of ammunition as early as 1915. Altogether one can speak

[3] All the translations of the German quotations are from the author.

in retrospect of a compensation strategy, because the syntheses and substitutions replaced the lack of colonial production locations. This nexus was also noted abroad by the American Chemist Edwin Slosson :

> "Long ago it was said that the British ruled the sea and the French the land so that left nothing to the German but the air. The Germans seem to have taken this jibe seriously and to have set themselves to make the most of the aerial realm in order to challenge the British and French in the fields they had appropriated." (Slosson, 1921, p. 23)

Synthetic rubber joins in here: it was christened with the name Buna, shortened from the starting materials *bu*tadiene and *na*trium (German for sodium), which was used as a catalyst. A variant is Buna-S, a so-called mixed copolymer, in which styrene is mixed in. This Buna-S is even today by far the most important synthetic rubber internationally, because it is especially suited for automobile tires. These still consist, for the most part, of this material. Besides Buna-S, Buna-N is also produced, which is similarly very wear-resistant, but in addition is resistant to organic solvents and oils. Buna-SS is even more wear-resistant than Buna-S and similarly is especially suited for tires. Lastly Buna 85 and Buna 115 are produced, the so-called numbers Buna ("Zahlenbuna"), which are distinguished by their heat resistance (Treue, 1955b, 256). Altogether world rubber production is nowadays split into two thirds synthetic and one third natural rubber.[4]

The initiative for rubber synthesis came from the German chemical industry: The Bayer management conference of 18 October 1906 offered a prize of 20,000 Marks as a reward for the chemist who could find a process for synthesizing rubber or a substitute before November 1909 (Plumpe, 1990, p. 342). The chemist Fritz Hofmann took up the challenge and had success. In the laboratory in Elberfeld (today a city suburb of Wuppertal, North Rhine-Westphalia) he succeeded in polymerizing the hydrocarbon isoprene. The German Imperial patent office issued the dye factories previously known as Friedrich Bayer & Company in Elberfeld the patent Nr. 250690 for the "process for production of synthetic rubber" (Lanxess 2009a, p. 6). Later Hofmann developed a further synthetic rubber, methyl rubber. The German Kaiser Wilhelm II demonstratively supported this German material: In 1912 he outfitted his state limousine with automobile tires out of methyl rubber. Hofmann's methyl rubber was, however, too expensive for peacetime. In addition the Continental (company) in Hannover, a major tire company, declined to process it further because the quality was too poor (Plumpe, 1990, p. 343).

---

[4] Personal communication from Dr. Ernst Schwinum, Leverkusen.

- *Industrial Production of Rubber in Wartime Germany*

Nevertheless, in the war year 1915 it went into large-scale production, since the German Empire was cut off from the supply of natural rubber during World War I (Plumpe, 1990, p. 343-349). Rubber materials were of strategic importance, because, among other things, they provided insulation in the batteries of German U-boats. They were also necessary for gas-masks. The rubber-shortage in Germany made gas-masks frail and leaky (Slosson, 1921, p. 153). Until the end of 1919 the plant in Leverkusen produced 2524 tons of synthetic rubber. By today's measures this is not much, but it was sufficient for the German U-boat fleet of that time. After the war's end production was again discontinued because it was not profitable and in addition methyl caoutchuc's quality was too poor for use in automobile tires. Instead, natural rubber was used again. Between WWI and WWII, rubber research was taken up again in Summer 1926 by the IG Farbenindustrie AG (Plumpe, 1990, p. 349).

On the eve of World War II synthetic rubber, now in the shape of Buna-S, was again placed at the center of the national agenda. This substance was developed by Bayer in 1929, building on the prior work of Hofmann. At first they had not thought of industrial production, although Buna-S had many advantages over the methyl caoutchuc of World War I. This synthetic rubber had what it takes to be able to replace natural rubber in many important applications. But it was much more expensive than natural rubber. In October 1930, IG stopped the synthetic rubber project. Thus, as it seemed at first, this synthetic rubber would be excluded from having a societal and political life. The "salto mortale" which, according to Marx's analysis, every ware on the market has to make in order to transform the invested labor value into exchange value (Marx 1983, p. 67), failed, and indeed fundamentally.

With the Nazi seizure of power things changed. The Reichswehr was interested in synthetic rubber and established contact with the IG (Plumpe, 1990, p. 357). In Hitler's secret memorandum to the Four Year Plan, written in August 1936 and which only Göring, Blomberg, and later (1944) Speer received, the material was ordered, whatever its cost might be. Hitler had a very strong interest in synthetic rubber. It is speculation whether this connects to the biographic fact that he was poisoned with mustard gas in October 1918, perhaps due to an inefficient, rubberless gas-mask. In any case, he knew that for modern, highly motorizeid war rubber was indispensable. And chemistry was to deliver it. n *Mein Kampf* he had already emphasized that the present "is reigned by technology and chemistry" (Hitler, 1943, p. 469). In his memorandum he wrote:

> It is just as obvious to organize and secure the mass fabrication of synthetic rubber. The claim that the process is perhaps still not completely clarified and similar excuses are from now on to be silent. […] The question of the cost price of this raw material is similarly completely irrelevant, for it is still better we produce expensive tires in Germany and can drive on them […]".[5]

Hitler pushed through 'his thing' against strong doubts, such as those expressed by Hjalmar Schacht (Treue, 1955a, p. 195-205). The German synthetic rubber became a reality in the very same year.

The goal that Hitler's order for rubber production should serve was clear, if one considers that rubber is essential for military vehicles, tanks, planes. More than 10 percent of the weight of a U-boat consisted of rubber (Klemm, 1960, p. 53). Hitler expressed his secret goal in 1936, which he endeavored to reach via synthetic rubber and the Four Year Plan at the end of his document: "I therefore set the following tasks: I. The German Army must be combat-ready in four years; II. The German economy must be war-capable in four years" (Treue, 1955a, p. 210). Synthetic rubber came into the world as part of the Nationalist Socialist mobilization, together with the Volkswagen, the autobahns, and finally the *Blitzkrieg*. Because Buna-S was three times more expensive than natural rubber, it would presumably have never gotten off the ground if not for its political godfather and the lack of German colonies. But when power politics necessitated ramping up production of synthetic rubber on a large scale for the purpose of war preparations, the innovation process took effect and the necessary technical knowledge grew apace, until synthetic rubber could compete with natural rubber (Streb, 2003, p. 97-132). The capabilities of the chemists and engineers zealously followed Hitler's desire (Maier, 2015). The entire rubber industry was "bunized", for the new peoples' comrade could not be processed with the machines used for natural rubber. Not only was the industrial technology in no way designed for the stuff, but economic concerns were also expressed. The rubber processing industry resisted, explained that the new material required five times, if not eight times more processing effort than good old natural rubber (Treue, 1955b, p. 256). This did not hold up the order. Thanks to new machines and sales paths, numerous solutions to technical problems (Erker, 2005, p. 423-445), inventions, and patents, whole new factories grew up with breathtaking speed around the substance. Hitler's authority allowed the previously only

[5] From (Treue, 1955a, p. 208). Treue (1955b) writes "augenblicklich" ("immediately") instead of "augenscheinlich" ("obviously").

dreamed of synthetic rubber to become a reality. In a monograph the economic historian Jochen Streb (2003) has thoroughly analyzed the successful National Socialist innovation politics and compared it, at least from a purely technical standpoint, with the United States in the same epoch.

Also in 1936 the IG Farben concern began the construction of a major industrial plant for production of synthetic rubber in Schkopau in Saxony. Later large plants were also set up near Marl, Ludwigshafen, and Auschwitz. All these plants still produce synthetic rubber today. Above all, Buna-S was produced since it was best suited for tire production (Streb, 2003, p. 99). The build-up of the synthesis route per order was successful; in Germany, Buna-S production exceeded domestic consumption in 1943.

The Making of Rubber Narratives in German Popular Literature

I dealt so extensively with the chronicle of the German rubber industry because it is only possible to determine what is lacking in German popular books on the topic if one has a sufficient background of sound historical information. The narratives presented there create their specific perspective mostly by the emphasis and amplification of a selection of facts. We do not find, for example, any mention in the popular literature of the reluctance of the rubber industry, to work with the expensive synthetic rubber. Instead, everybody works together to achieve the noble goal. Not only the machines were "bunized", but also peoples´ minds. The Führer´s national emotionalism was so strongly projected onto domestically-produced rubber, even before the construction of the Buna plants, that it experienced s sort of second, ideological vulcanization. Home-made synthetic rubber was perceived as a valuable national product. Yet at the same time, it was seen as a contribution to the progress of all mankind because synthetic rubber liberated the oppressed and was said to bring more justice to the world. In this way users' acceptance was fostered and its legitimacy was underscored with regard to Germany's distrusted neighbor-states.

- *"Red Rubber" in the Colonies of the European States*

Just as politics motivated and steered work on rubber synthesis with its goal setting, thus now the scientific-technical result was reformulated into a political victory. German synthetic rubber was embedded in the great national myths, so that not only the invention was celebrated as a patriotic feat, but also its use was virtually equated with a fulfillment of duty. It was taken as a demonstration of where the new Germany stood and where it wanted to go. It is important to note that these national goals were not un-

derstood as an outflow of hubris, but rather as a specifically German contribution – completed with science and technology – to world peace, to reconciliation between peoples, and to the liberation of the oppressed.

In particular, the 'cleaner' character of the new production methods was often pointed out. In the view of authors in that era, this 'cleaner' production rose above the cruel production methods of the colonial rulers. German non-fiction books brought out the gruesome dark sides of natural rubber, the rubber of the others.

These dark sides were well known in those days. They had come to light through popular books. In 1906 the British-French journalist Edmund Dene Morel published his attention-arousing work *Red Rubber* (from which parts were translated into German), in which he denounced the conditions in the Congo, which since 1885 was a "free state" in possession of the Belgian king Leopold II. At the center of Morel's critique stood the system of forced labor introduced by the Belgian monarch, which required the natives to collect caoutchuc for the agents of the king, who afterward sold it on the European markets. Gatherers who refused to participate in the production or who did not deliver enough caoutchuc were victims of sadistic punishments. The merciless exploitation by the Belgian colonial rulers, who in no way spared women and children, led to such a massive decimation of the local population, that today it is referred to as a genocide. These events were not just described by writers – such as Joseph Conrad (1902), whose *Heart of Darkness* reflected the experiences of a journey in the Congo – but were also denounced by missionaries, travelers and politicians. Horrors were also known from the Peruvian Amazon area. In 1909 Roger Casement reported on the orgies of cruelty in the caoutchuc areas on the upper Amazon (Taussig, 1984). In 1913, Walter Ernest Hardenburgs published *Putumayo – The Devil's Paradise*, in which he reported on a system of forced labor on the Putumayo River in northwest Amazonia that was shockingly similar to that which Morel had described (Taussig, 1984).

In Europe it was generally known that natural rubber was a blood-stained thing. One might wonder whether the decision of the Bayer management conference in October 1906 to foster research on synthetic rubber might have been influenced by Dene Morel's revelations concerning the red rubber, which were published the same year and immediately sparked discussions internationally but also in Germany. This is not very plausible, though, as there were strong enough economic reasons: "the world was willing to pay $2,000,000,000 a year for rubber and the forests of the Amazon and Congo were failing to meet the demand" (Slosson, 1921, p. 146).

- *"Buna – Victory of Reason!": Science and Technology for a Peaceful World*

In the popular literature, Germany's lack of colonial experience was turned from a deficit into a plus, in order to equip the synthesis program with an aura of moral superiority. Germany's separate scientific-technical modernization was put into perspective as an exemplary German and morally superior route. It is no accident that the depiction of the horrors in the Congo as well as those on the Putumayo (Fischer, 1938, p. 37-87; p. 118-148) appears at the beginning of a political-technological vision in Karl Fischer's non-fiction work *Blutgummi* (*Blood Rubber, Red Rubber*) That vision imagined the industrial rubber synthesis developed by the German scientists leading away from the cruelties of colonial caoutchuc production. Cleaner science and technology legitimized Germany's claim to leadership. In this ideologization synthetic rubber adopted an identity-stabilizing function: synthetic rubber materializes the moral and intellectual superiority of the Germans.

The chapter dedicated to the new substance in the book *Blutgummi* is called: "Buna – Triumph of Reason" (Fischer, 1938, p. 207). In it the German substance is portrayed not only as technically superior, but also as the fulfillment of humanitarian values. Indeed, it is conceded that the British plantation caoutchuc was a first step to more humane production methods. But one had stopped halfway: "If now there was no more struggle over bloody rubber and no-one need any longer lose health and life, however, thus continued the monopoly reign of the rubber barons – only that instead of the whip the price tag stepped in" (Fischer, 1938, p. 18).

In this perspective overcoming "the capitalistic and geographic monopoly through the strengths that are awarded to the human understanding and not their economic power: through the synthesis of mind and nature" (Fischer, 1938, p. 19) was reserved for synthetic rubber. Toward the end of his book Fischer declare festively: "But as in those days the first ton of plantation caoutchuc already meant a victory over red rubber, so already the first Buna tires mean a triumph of moral and reason over the speculative economy, a triumph of mind over money and the market" (Fischer, 1938, p. 241). At the same time he emphasized the nationality of the substance: "What is here produced is German rubber, rubber whose development one regulates, whose characteristics one can adjust to the requirements of its later life, that one can make more wear resistant or more oil resistant or more aging resistant than the natural rubber" (Fischer, 1938, p. 240). Synthetic rubber thus reveals itself as a Prussian soldier, duty conscious and resistant, scientifically structured through and through, exact, obedient, and mission-ready at any time. Rather than a bad substitute for natural rubber, it confidently appears as perfection become substance.

The writer Anton Zischka also celebrated the German rubber story in his work *Science Breaks Monopolie*s, which was printed more than 600,000 times and also translated into 16 languages (Weber, 1999, p. 219). The rubber chapter of the book was entitled "Rubber from lime and coal versus 'red rubber' (Blutgummi)". Zischka (1937, p. 185), whose works were also printed in large numbers outside Germany (on Zischka with further references Weber 1999, Hahnemann 2008), explained: "rubber from lime and coal versus 'red rubber', this is only a single building block in the great building of the new world. But it is also a symbol. Peace and progress instead of war and plunder. Science will make a reality out of an utopia. German science especially". In Zischka's logic the fight against monopoly leads, with the help of science, not to war but by logical necessity to peace: "If we [...] break monopoly… then we overcome also the fear of hunger and exclusion. Then we fight jealousy and enviousness. Then we work for a *lasting* peace, for who would fight for something that *all* have?" (Zischka, 1937, p. 185, his emphasis). The researchers thereby get a key role: "Monopoly upon monopoly was broken, step by step the forward-probing researchers conquered ever new living space, *ended fights over raw materials, by making them available to all.*"

Here is sketched, in contrast to other forms of global economics, a specifically German modernization ideology that is based not on exploitation, but on science and technology. This should be, so it is claimed, the best politics of peace, because with the lifting of scarcity the reasons for war are also removed. This ideology is not German in the sense that it is a German "invention". We find it already fully expressed in the works of, for example, Marcelin Bertholet, the most influential French scientist of the late 19th and early 20th century. Bertholet, the inventor of the term "chemical synthesis", already imagined a clean world of synthetic wonders in the year 2000, where not only materials but also human food would be produced synthetically out of carbon dioxide and water, the necessary energy being delivered by the sun. Human minds would be made peaceful by certain chemicals… (Bertholet, 1896, p. 508-515). The topos could even be traced back to the alchemists of the early modern era who, like the Rosicrucians, combined a chemical utopia (production of gold out of other metals) with a social one… But let us return to popular literature.

Karl Aloys Schenzinger (1937, p. 375-376), one of the most successful German authors of the first half of the 20th century, similarly used the *topos* in his novel *Aniline*. Schenzinger, however emphasized above all the national increase in power that would become possible through the synthe-

sis.[6] The widespread influence of Schenzinger´s novel can hardly be overestimated. *Aniline* was the most sold book in the Nazi period in the German Reich, with a printing of over 920,000 copies alone until 1944 (Schneider, 2004, p. 80-81), around one tenth of the number of *Mein Kampf* copies.[7] It formed the chemical understanding of multitudes of people and was even successful after the end of the war in a lightly cleaned-up edition. The book was reprinted in Germany into the 1970s.

The chemist is often depicted in Schenzinger's novel as exemplifying the "Nordic performance type" in the sense of the colorful Husserl-student and race-theorist Ludwig Ferdinand Clauß (1929, p. 1-10). These men are performance-oriented, they do not make a fuss about themselves, they are objective: one contrast to the Nordic type in Clauß' typology is the audience-oriented "Mediterranean show-type" (Clauß, 1929, p. 11-15). This idea of a typical German character who is tough, does not give up, etc. was also prominent in the self-perception of German chemists (Duisberg, 1933, p. 207).

As most of the quoted books were published in the Nazi period, it is important to note that the central narrative of the scientist who liberates his country with his inventions (Soentgen, 2014) has older roots. It was already present in a seminal state in the science-fiction novel Kautschuk by Hans Dominik, which was published during the Weimar Republic in 1930. There, the chemist Dr. Fortuyn invented the "electro-synthesis" of rubber, which surpasses even chemical synthesis. Spies from other countries (USA, France, Great-Britain) try, with a great deal of criminal energy, to get hold of the secret. But they fail. In the end, the foundations are laid for gigantic synthetic rubber plants. The rubber-plantations in tropical countries will be stubbed out…

Carl Duisberg, the head of the supervisory board of IG Farben and the most powerful chemist in the Weimar Republic (and at that time probably worldwide) also had the scheme in mind when he explained in a public

---

[6] The following passage is deleted in the post-war edition: "No naphtha source, no oil, no rubber in one's own country. No colonies. Dangerous sums threaten to flow out to foreign countries. We are hemmed in, geographically, scientifically, politically. We want to live! Ever louder is the support for the artificial material. The artificial material today determines the future of the German nation. The artificial material has become a question of German existence. But there now the German chemist is already aroused, [...] From coal and lime one came to calcium carbide, from there to acetylene, from acetylene to butadiene through polymerization to Buna, to synthetic rubber." (Schenzinger, 1937, 375 f.)

[7] Hitler's *Mein Kampf* had been printed 10,240,000 times by 1943 (Hitler 1943, cover).

speech in December 1929 that the chemical industry had a special significance for Germany because only that industry could transform poor German raw materials into valuable products (Duisberg, 1933, p. 208). Fritz Haber had very similar thoughts of (1927, p. 9): in a speech in Argentina in 1923 he emphasized that chemistry was a typical German thing, as in Germany chemistry compensates for the lack of raw materials with "innovative mind".

The quotations make clear that the chemical synthesis was presented as an ethically motivated compensation strategy of a people, who fell short in competition for colonies due to their tardy national unity and consequently based their economic – and thereby also political – power on chemical synthesis. Chemistry, however, was supposed to not only free the Germans and make them powerful, but also bring peace, justice, prosperity, and freedom to all mankind. German scientists would solve the resource-scarcity-problem and allow everyone to live in peace. The history of German synthetic rubber in the subsequent Nazi Period is as far from this claim as one could possibly think. German synthetic rubber did not and was not meant to serve peace and justice and freedom. We have to turn to the chronicle once again.

- *The German Red Rubber: IG Farben Buna in Auschwitz*

The IG Farben Company – attributed such an important role as a liberator of mankind by Schenziger – instead used the Holocaust for its own purposes. The IG Farben plant Buna IV, set up at the desire of IG Farben after 1941 in the camp Auschwitz-Monowitz under the supervision of the SS, had the purpose of supplying synthetic rubber (Lautenbach, 1995). This decision, made in the IG Farben headquarters in Frankfurt, contributed to the fact that the camp in Auschwitz was built up into the central death camp in the system of National Socialist concentration camps. Through this decision, Himmler´s attention was directed to the location (Wagner, 2000, p. 285). For Himmler the IG Farben decision was welcomed; it offered him the possibility to take part in armaments projects. The chemists responsible on site and at the IG Farben headquarters in Frankfurt soon determined that the totally exhausted and emaciated camp inmates were not very productive. They did not, however, draw the conclusion that they should insist on better working conditions for the Jewish prisoners. Rather they proposed to more quickly replace the 'used up' prisoners with new ones.

The "used up" prisoners were gassed in Birkenau. Individual punishments of prisoners were also requested by IG managers and promptly carried out by the SS. Thus, the librettist and author Fritz Lohner-Beda,

who had composed a sad "Buna song" in Auschwitz, was beaten to death after IG Farben managers complained about his, in their eyes, meager work performance (Schwarzberg, 2000, p. 158-171; Hilberg, 178, p. 596). Out of a total of around 35,000 camp inmates who worked there, more than 25,000 died as a result of their work for the German Buna (Steinbacher, 2004, p. 42 & 47). The life expectancy of the camp inmates was on average three months, sometimes only a few weeks. The single steps of the synthetic route to Buna became to them stations in their way of suffering and death:

> The Carbide Tower, which rises in the middle of Buna and whose top is rarely visible in the fog, was built by us. Its bricks were called "*Ziegel*, *briques, tegula, cegli, kamenny, mattoni, téglak*", and they were cemented by hate; hate and discord, like the Tower of Babel, and it is this that we call it – *Babelturm, Bobelturm* – and in it we hate the insane dream of grandeur of our masters, their contempt for God and men, for us men. (Levi, 2006, p. 78-79).

The Buna-plant, which shaped the life of the chemist Primo Levi in a horrible way (Maier, 2015, p. 554-555), did not produce one single ton of synthetic rubber during WWII. However, it was put to work after WWII by Polish authorities in Upper Silesia and is working still.

After the end of WW II German synthetic rubber production was in good shape technically despite war damage and dismantling, thanks to years of sponsorship by the National Socialist state. However, it needed economic support for a transition period, because it could still not compete in price with natural rubber. In the young Federal Republic of Germany (BRD) a compensation fund was set up into which all caoutchuc-importing businesses would pay a specific sum per imported kilogram. Federal economics minister Erhard signed the decree PR Nr. 42/52 on 17 May 1952 (Kränzlein, 1980, p. 114-115) The fund existed until 1958. Eventually German synthetic rubber became competitive enough that it could exist in the market without political support. The German Democratic Republic (DDR), meanwhile, possessed a large production location at the plant in Schkopau. In the DDR's planned economy synthetic rubber was surrounded by political objectives for much longer, namely until the fall of the Berlin Wall.

Some IG Farben chemists were convicted as war criminals in the Nürnberg trials for their participation in IG Auschwitz. They were soon set free and again continued their careers in the chemical industry. In addition, IG Farben, before it was disbanded, paid an indemnification to the survivors of the camp. From this point on the popular Buna stories separated into two lines. The one was spun in the DDR, the other in the BRD.

- *"Elaste" in the DDR: Return to Utopia*

The DDR was founded in 1949. Within its state territory it possessed the Schkopau Buna plant, a huge factory for synthetic rubber. With the reactivation of production the bloody history of this rubber had to be dealt with. This was reflected in the popular literature, which showed an interesting and surprising continuity with the story-lines of the Nazi-period.

The story of the fight against monopoly was easily accepted from the Nazi period and for the most part continued with a few changes. The National Socialist state had not overcome the red rubber, that was evident. But why? The answer was given in popular books: because it was directed by capital. The actual overcoming of red rubber was reserved for socialism. This line made possible an important continuity between the National Socialist-histories and the DDR stories: the chemists remained on the side of the good, they remained bringers of progress. They were not guilty. Only guilty were the capitalists, the IG Farben directors. Thus the lines between friend and foe were drawn anew.

When Johannes Kropf (1949) published a short story *From Red Rubber to Buna*, there were scarcely any changes with regard to the stories from the National Socialist period. Synthetic rubber would be the solution against exploitation and cruelness. Rubber chemists were thus turned into the heroes of the working class, instead of the German people. Then, however, the lines were adjusted to the new situation. Peter Klemm, whose book *Dethroned Gods – Stories about Raw Materials* begins with the chapter "Red Rubber to Buna", described the "lords of the IG Farben" not as apostles of clean and fair rubber, but rather the opposite: as warmongers, promoters of fascism who wanted nothing other than war. They ardently desired war, according to Lenin's teachings about imperialism as the last stage of capitalism: "The German imperialists not only counted on it [the war], they strived for it, because, yes, they still wanted to reach the old goals that they had not reached in the first World War – the new partitioning of the world" (Klemm 1960, p. 47). While in non-fiction books of the National Socialist period the IG Farben managers, without exception, were positively portrayed as real chemists who at the same time were great businessmen, popular authors now drew a distinction between the capitalistic bosses and "their chemists". It was the capitalists who had really caused the war, they and their "Nazi generals". Chemists were now portrayed as victims, robbed of the fruits of their labor, indeed, tangled in a new war that

threatened to destroy their entire achievement.[8] As Manfred Künne argued in his novel *Buna*, the third part of his great caoutchuc trilogy which appeared in 1985, four years before the fall of the Berlin Wall: Only Socialism is summoned to break monopoly without setting up a new one.

Synthetic rubber and the stained white smocks of the chemists were washed clean in this literature. With that, the past, as far as the DDR was concerned, was "overcome". With this synthetic rubber ('Elaste') could again become a utopian substance, a substance which would be part of a "better world":

> "Out of the stinking material, out of rubber, profit and blood, by us out came a material that one can take in the hand without dirtying it. It combined the knowledge of the learned, the bitter experience of the working class under capitalism and the élan of the youth. It is a product out of applied natural laws and the laws of societal development – out of chemistry and socialism." (Klemm, 1960, p. 62)

Thus in the DDR literature the story from the National Socialist period was continued, if with important changes. In this literature synthetic rubber still serves to overcome colonialist oppression, has a global mission as a symbol of peace, freedom, and justice and is not just an instrument of national power strategies. Yet whoever would think that these Buna writings from the DDR are embarrassing efforts, that they drip with ideology and have hardly anything to do with reality has not read the writings published by the chemical industry in West Germany. Compared with the BRD-stories one can consider the DDR writings in all their eccentricities as pure enlightenment. Of course the hypothesis in all of the socialist synthetic rubber books that war guilt lay not with Hitler, but rather with the capitalists who had wanted the war (in view of IG Farben's enormous export market) is not convincing. But at least in these DDR-writings the attempt is make to take issue with the German red rubber. To be sure, the result is distorted and one-sided, but at least the central facts are determined and the names of the chemists responsible for the IG Auschwitz are given. In contrast the specific texts meant for a broader public published in West Germany nearly completely ignore the topic.

---

[8] "Now, the IG Farben in fact broke the monopoly, but the concern at the same time attempted to erect a new one. It wanted the synthetic rubber, the result of the scientific efforts of the chemists. But this monopoly was already broken, even before it could even be set up, even before there was Buna or wheels that rolled on Buna for war. The reason for this was the Soviet Union and socialism." (Klemm 1960, p. 48).

- *The 'Jack-of-All-Trades': Buna in the BRD*

After the break-up of IG Farben by the allies the unteachable Karl Aloys Schenzinger (1953) wrote an IG Farben tragedy novel, in which he, in a strongly glossed over depiction, once more put its splendid work into the limelight and even praised, of all things, synthetic rubber (alongside synthetic fertilizer and synthetic gasoline). Nowhere in the book is there mention of IG Auschwitz and the heads and chemists of IG Farben are without exception depicted in a positive light. IG Farben's Buna plant in Auschwitz is spoken of nowhere. Nor is Auschwitz missing only in Schenzinger's book. Even the historian Wilhelm Treue does not mention it in his solid, Hitler-critical monograph on "Rubber in Germany", although with 600 million Reichsmarks it was one of the largest investment projects of WW II (Steinbacher, 2004, p. 37). These memory lapses were not only a literary phenomenon but also a social one. These lapses highlight that those in the German chemical industry who were responsible for IG Auschwitz, such as Otto Ambros, Walter Dürrfeld, Heinrich Bütefisch, and Fritz ter Meer were very soon again busy in the chemical industry after a short incarceration in the Landsberg war criminals prison (Maier, 2015, p. 256).

Historical research has thoroughly reappraised the interconnections of chemistry and politics in the synthetic rubber industry and especially IG Auschwitz (Lorentz & Erker, 2003). In popular books dedicated to synthetic rubber however, the topic is not addressed. If one looks through the synthetic rubber histories of Bayer AG, Hüls AG, or the newest, Lanxess AG – the word Auschwitz is not found therein. Directly after WWII, the town-name Auschwitz also became a taboo in German chemical journals (Maier, 2015, p. 555-556). Instead, the individuals responsible for IG Auschwitz, such as Otto Ambros, received an honorable remembrance.[9] But industrial publications were not only places where the interconnections of synthetic rubber and the Holocaust were inadequately explored. Also in the volume *Rubber – the Elastic Fascination*, in which the Berlin technology museum participated, out of 383 pages only a single one is dedicated to Auschwitz (Giersch & Kubisch, 1995, p. 155).

This must be even more remarkable as *The Periodic Table*, a book by the Buna survivor Primo Levi, is read by many chemists. However, his Auschwitz Buna book, *If This Is a Man*, seems to be less well-known among

[9] See for example the picture insert in Kränzlein (1980). Kränzlein was involved in Buna production in WWII, but not in Auschwitz (Maier 2015, p. 93). On Ambros, who thought he was an innocent victim, see Westermann (2007, p. 87-96) and also, with new sources, Maier (2015, p. 113).

German chemists. In contrast to the DDR literature, in the later BRD histories caoutchuc is no longer represented as a political substance. There is a noticeable break in the rubber myths.

In the West Germany industry publication put out shortly before and after the fall of the Berlin Wall caoutchuc is instead portrayed as a faceless, apolitical, technically perfect substance. Synthetic rubber is politically relevant only insofar as its production contributes to economic growth. This sounds very modest and in a way also a bit boring. But this new, humble rubber myth integrated itself into a general trend in the Federal Republic, for which economic success stood at the center. Indeed, the historian Werner Abelshauser (2004, p. 11) wrote that "German history since 1945 is above all economics history" and that the "West German Federal Republic [...] for a long time was like a successful economy in search of the purpose of its political existence". Synthetic rubber's depiction has shifted from Fischer's (1938) "Triumph of Reason" to the "Triumph of Chemistry" presented in a Bayer commemorative publication from 1988 (Verg *et al.*, 1988, p. 248).

Similarly, Lanxess AG (2009a), at this time the world's largest producer of synthetic rubber for tires and seals (and a spin-off of Bayer AG) put out a commemorative publication for synthetic rubber's "100 Year Anniversary" which depicted it as a "tailored" material whose characteristics can be adjusted much more exactly to its technical functions than would be the case with natural rubber. Innovation was now the key term of the narrative for the 100th anniversary of the invention of synthetic rubber.[10]

In other words, without synthetic rubber, no "modern world"! Synthetic rubber is now an internationally-active "many-faceted problem-solver" (Lanxess 2009a, p. 15): a "Formula for Success" or simply a 'jack-of-all-trades'. It is useful everywhere – a *materia universalissima*. This peaceful rubber fearfully avoids acting aggressively: rather it is a confirmed pacifist which is everywhere where people have fun. Possibly for this reason the company's anniversary commemoration was moved to the year 2009, so that they could celebrate synthetic rubber as an innocent scientific discov-

[10] "without modern rubber species out of the retort as for example Therban(R) (HNBR = hydrated acrylonitrile-butadiene rubber), Levapren(R), Levamelt(R), Baymod(R) L (EVA= ethylene-vinyl acetate rubber), Bapren(R) (CR = chloroprene rubber), Krynac(R), PerBunan(R), Baymond(R) N (NBR = acrylonitrile-butadiene rubber), Krylene(R) and Krynol(R) (styrene-butadiene rubber) as well as BUNA(R) EP (EPM/EPDM) = ethylene-propylene rubber) would neither mobility nor machine construction, neither electricity transmission nor space travel, nor modern architecture or raw materials processing be possible in their present form" (Lanxess, 2009a, p. 13).

ery of the year 1909 while putting the connection to armaments in the background. The war year 1915 probably did not come under consideration for the company and certainly not the year 1936, although these dates could make a better claim as the real birth year of German synthetic rubber. On the web, history is centered on the year 1909, while the time between 1909 and 2009 remains diffuse:

> "Hofmann and his successors encountered numerous setbacks in their quest for an economical and usable synthetic rubber, but by searching for new processes and building large-scale plant at great expense they finally succeeded." (Lanxess, 2009b, slide 2).

That one of these "large-scale plants" built by Hofmann's successors of Hofmann was part of Auschwitz, is not mentioned. Instead, the most important point seems to be the success of the substance.

Thus the new German rubber books are distinguished by the attempt to normalize the substance, to depict it as a useful, harmless invention and to blend out its terrible political past. Yet even this attempt to make the substance apolitical, is, however, a political positioning. It fit into a political atmosphere at the time in which the Federal Republic of Germany saw itself as a similarly pacifist, economically successful "problem-solver".

Conclusion

Popular books on science, as Ludwik Fleck pointed out, portray science for the general public. A certain simplification, as Fleck already noted, is indispensable for this. However, our short analysis of German popular books on synthetic rubber shows that there is not only simplification but also – so to say – complication. On the one hand, the complexity of the research and development process and of the historical context is significantly reduced. On the other hand, something is also added: a typical narration-scheme which presents the chemist as a heroic liberator. With his invention, he liberates first his country, and then in the long run all mankind. This narration scheme is especially abundant in popular books published in Nazi Germany, but it can be traced back to alchemical writings of the early modern period. Rubber chemists played different roles according to different political contexts in 20th century Germany: during the Nazi period, they saved their people; during the Soviet era in the DDR, they saved their social class; during the Liberal era in the BRD, they saved the economy. There, the narrative gradually depoliticized, as synthetic rubber

was presented as a peaceful substance serving any technical purpose and, thereby, economic growth.

Does the popular discourse on synthetic rubber have any relation to the "bench", to the laboratory of the rubber-chemist? Fleck argued that popular books also influence the scientist himself. That is plausible, and the author knows rubber-chemists who state that they love Schenzinger's books. Yet it seems hard to get more than such anecdotal evidence for the thesis. On the other hand, the books themselves are often influenced by the scientists, as they were sometimes involved in the process of creation of these books.

One function of popular books on synthetic rubber is the legitimation of rubber chemistry as a work of national importance and human significance. They intend to present rubber-chemistry as something great. In this respect, they have an important function in motivating young people to start a career in the chemical industry. All in all, their function seems to be less important on a theoretical level. But science is not only a theoretical and experimental and technical endeavor. It is also, and in a certain sense especially, a social endeavor which will cease if society does not accept and fund scientific research and development or if there are not enough young people who think it worthwhile to engage in it.

It should not be forgotten that alongside the positive discourse on chemistry, there also exists a critical public discourse on chemistry, a counter-discourse so to say. This discourse started with critical publications on the development of chemical warfare in WW I after 1918 (Woker, 1925) and was also later focused on dissipating substances, especially gases and aerosols. But that is a different story…

Acknowledgment

I would like to thank two anonymous reviewers for valuable suggestions. Thanks also to Prof. Dr. Silvia Serena Tschopp and Patrick Ramponi for the intensive exchange of ideas on rubber in the context of a plan for a joint research project that unfortunately was not supported and thereby could not be carried out, but which nevertheless led to further research. I thank the team of the science division of the library of Augsburg University, especially Gabriele Biehler, for help with our book-collection "substance stories". And last not least I thank the chemist and rubber-specialist Dr. Ernst Schwinum (formerly Bayer AG, Leverkusen) not only because he early on decisively fostered my enthusiasm for chemistry, but also for valuable first-hand information on caoutchuc and Buna and for the possibility to obtain very concrete experience with Buna and other elastomers in the

Testing Laboratory of the Bayer AG. For errors that possibly remain in the text in spite of careful editing, none of the above-named is responsible, but solely the author.

References

ABELSHAUSER Werner (2004), *Deutsche Wirtschaftsgeschichte seit 1945*, Bonn, Bundeszentrale für politische Bildung.

BERTHELOT Marcelin (1896), *Science et Morale*, Paris, Calmann-Lévy.

BERTSCHIK Julia (2008), "Nationalsozialistische Popularisierung des Wissens. Das Textilsachbuch im 'Dritten Reich'", in A. HAHNEMANN & D. OELS (eds.), *Sachbuch und Populäres Wissen im 20. Jahrhundert*, Frankfurt am Main, Lang, p. 149-158.

CLAUß Ludwig F. (1929), *Von Seele und Antlitz der Rassen und Völker. Eine Einführung in die vergleichende Ausdrucksforschung*, München, Lehmanns Verlag.

CONRAD Joseph (1902), *Youth. A Narrative and Two Other Stories (Heart of Darkness),* London, William Blackwood & Sons.

DUISBERG Carl (1933), *Abhandlungen, Vorträge und Reden aus den Jahren 1922-1933*, Berlin, Verlag Chemie.

ERKER Paul (2005), *Vom nationalen zum globalen Wettbewerb. Die deutsche und die amerikanische Reifenindustrie im 19. Und 20. Jahrhundert*, Paderborn, Ferdinand Schöningh.

FISCHER Karl (1938), *Blutgummi. Roman eines Rohstoffs*, Berlin, Kommodore Verlag von Killisch-Horn & Co.

FLECK Ludwik (1980), *Entstehung und Entwicklung einer wissenschaftlichen Tatsache. Einführung in die Lehre vom Denkstil und Denkkollektiv,* Frankfurt am Main, Suhrkamp Verlag.

FOUCAULT Michel (1981), *Archäologie des Wissens*, Frankfurt am Main, Suhrkamp Verlag.

FRANZKE Lothar (1939), *Vom Kautschuk zum BUNA,* Berlin, Wilhelm Limpert Verlag.

HABER Fritz (1927), *Aus Leben und Beruf. Aufsätze, Reden, Vorträge*, Berlin, Julius Springer.

HAHNEMANN Andy (2008), "Vom Sieg der Arbeit. Anton Zischkas Briefwechsel mit seinem Verleger Wilhelm Goldmann 1934-1950", in A. HAHNEMANN & D. OELS (eds.), *Sachbuch und populäres Wissen im 20. Jahrhundert*, Frankfurt am Main, Lang, p. 123-135.

HARDENBURG Walter E. (1913), *Putumayo – the Devil's Paradise; Travels in the Peruvian Amazon Region and an Account of the Atrocities Committed upon the Indians Therein*, London, T. Fischer Unwin.

HILBERG Raul (1978), *The Destruction of the European Jews*, New York, Octagon Books.

HITLER Adolf (1943), *Mein Kampf*, München, Zentralverlag der NSDAP.

HOFMANN Fritz (1936), "BUNA und Kriegskautschuk aus Kohle", *Die Naturwissenschaften*, n°27, 3 July, p. 423-426.

JACKSON Joe (2008), *The Thief at the End of the World. Rubber, Empire and the Obsessions of Henry Wickham*, London, Duckworth Overlook.

JÜNGER Wolfgang (1940), *Kampf um Kautschuk,* Leipzig, Wilhelm Goldmann Verlag.

KLEMM Peter (1960), *Entthronte Götter. Geschichten um Rohstoffe*, Berlin, Verlag Neues Leben.

KRÄNZLEIN Paul (1980), *Chemie im Revier: Hüls*, Düsseldorf und Wien, Econ Verlag.

KROPF Johannes (1949), *Vom Blutgummi zum BUNA. Werner und Peter auf Entdeckungsfahrten,* n°9, Halle, Mitteldeutscher Verlag.

KÜNNE Manfred (1985), *Buna – Roman eines Kunststoffes*, Halle/Leipzig, Mitteldeutscher Verlag.

LANXESS AG (2009a), *100 Years Synthetic Rubber. Creating the Way the World Move Today*, Leverkusen, Lanxess AG.

LANXESS AG (2009b), *100 Years Synthetic Rubber,* Oneline: https://lanxess.com/uploads/tx_lanxessmatrix/lanxess_ar09-english.pdf, retrieved June 2017.

LEVI Primo (2006), *If This Is a Man*, London, Abacus.

LEWIS R. A. (1979), "Innovation in the USSR: The Case of Synthetic Rubber", *Slavic Review*, vol. 38, n°1, p. 48-59.

LORENTZ Bernhard & ERKER Paul (2003), *Chemie und Politik, Die Geschichte der Chemischen Werke Hüls 1938 bis 1979. Eine Studie zum Problem der Corporate Governance,* München, C. H. Beck.

MAIER Helmut (2015), *Chemiker im „Dritten Reich"*, Wiley-VCH, Weinheim.

MARX Karl (1983), *Das Kapital. Kritik der Politischen Ökonomie. Erster Band*, Berlin, Dietz Verlag.

MERKI Christoph M. (2002), *Der holprige Siegeszug des Automobils 1895-1930 – Zur Motorisierung des Straßenverkehrs in Frankreich, Deutschland und Schweiz*, Wien, Böhlau Verlag.

MOREL Edmund D. (1906), *Red Rubber. The Story of the Rubber Slave Trade Flourishing on the Congo in the Year of Grace 1906*, New York, The Nassau Print (Reprint : Honolulu, University Press of the Pacific, 2005).

MORRIS Peter J. T. (1989), *The American Synthetic Rubber Research Program*, Philadelphia, University of Pennsylvania Press.

PLUMPE Gottfried (1990), *Die I.G. Farbenindustrie AG, Wirtschaft, Technik und Politik 1904-1945*, Berlin, Duncker und Humblot.

SCHAPP Wilhelm (1953), *In Geschichten verstrickt. Zum Sein von Mensch und Ding,* Hamburg, Richard Meiner Verlag.

SCHENZINGER Aloys (1937), *Anilin*, Berlin, Zeitgeschichte Verlag.

SCHENZINGER Aloys (1953), *Bei I.G. Farben*, München, Wilhelm Andermann Verlag.

SCHNEIDER Tobias (2004), "Bestseller im Dritten Reich. Ermittlung und Analyse der meistverkauften Romane in Deutschland 1933-1944", *Vierteljahreshefte für Zeitgeschichte*, n°1, p. 77-97.

SCHWARBERG Günther (2000), *Dein ist mein ganzes Herz. Die Geschichte von Fritz Löhner-Beda, der die schönsten Lieder der Welt schrieb und warum Hitler ihn ermorden ließ*, Göttingen, Steidl.

SLOSSON Edwin E. (1921), *Creative Chemistry. Descriptive of Recent Achievements in the Chemical Industries*, London, University of London Press.

SOENTGEN Jens (2013), "Die Bedeutung indigenen Wissens für die Geschichte des Kautschuks", *Technikgeschichte*, vol. 80, n°4, p. 295-324.

SOENTGEN Jens (2014), "Volk ohne Stoff. Vom Mythos der Ressourcenknappheit", *Merkur, Deutsche Zeitschrift für europäisches Denken*, n°2, p. 182-186.

STEINBACHER Sybille (2004), *Auschwitz. Geschichte und Nachgeschichte*, München, C. H. Beck.

STREB Jochen (2003), "Staatliche Technologiepolitik und branchenübergreifender Wissenstransfer. Über die Ursachen der internationalen Innovationserfolge der deutschen Kunststoffindustrie im 20. Jahrhundert", *Jahrbuch für Wirtschaftsgeschichte*, supplement n°4, Berlin, Akademie Verlag.

TARDE Gabriel (1921), *Les Lois Sociales. Esquisse d'une Sociologie*, Paris, Librairie Félix Alcan.

TAUSSIG Michael (1984), "Culture of Terror – Space of Death. Casement's Putumayo Report", *Comparative Studies in Society and History*, vol. 26, p. 467-497.

TREUE Wilhelm (1955a), "Hitlers Denkschrift zum Vierjahresplan 1936", *Vierteljahreshefte für Zeitgeschichte* (Jahrgang 3 1955), Vorbemerkung, p. 184-210.

TREUE Wilhelm (1955b), *Gummi in Deutschland. Die deutsche Kautschukversorgung und Gimmiindustrie im Rahmen weltwirtschaftlicher Entwicklungen. Herausgegeben im Auftrage der Continental Gummi-Werke Ag Hannover*, München, Bruckmann.

VERGL Erik, PLUMPE Gottfried & SCHULTHEIS Heinz (1988), *Meilensteine*, Leverkusen, Bayer AG.

WAGNER Bernd C. (2000), *IG Auschwitz. Zwangsarbeit und Vernichtung von Häftlingen des Lagers Monowitz 1941-1945*, München, K. G. Saur.

WEBER Heike (1999), "Technikkonzeptionen in der populären Sachbuchliteratur des Nationalsozialismus. Die Werke von Anton Zischka", *Technikgeschichte*, vol. 66, p. 205-236.

WESTERMANN Andrea (2007), *Plastik und politische Kultur in Westdeutschland*, Zürich, Chronos.

WOKER Gertrud (1925), *Der kommende Giftgaskrieg*, Leipzig, Oldenburg Verlag.

ZISCHKA Anton (1936), *Wissenschaft bricht Monopole*, Leipzig, Wilhelm Goldmann Verlag.