Mercurius Solis: Hunting a Mysterious Alchemical Substance

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Abstract

Treatises and reports of the late 16th and early 17th century give evidence that prominent alchemists of that time prided themselves on the preparation of a substance called Mercurius Solis. This very substance is mentioned by Matthäus Erbinäus von Brandau, Martin Ruland, Oswald Croll, Andreas Libavius and Heinrich Khunrath among many others. Yet in 1637 physician Johannes Agricola already expressed his doubt about the unreasonably high expectations concerning this „magic cure" – mostly described as a grey powder. The expectations included a great transmutational effect as well as a cure for syphilis. An important tract regarding the preparation of Mercurius Solis is "Lux in tenebris lucens" by Benedictus Figulus, which can be traced back to the Paracelsian Adam Haslmayr. Very similar quotes about Mercurius Solis can be found in a manuscript called „Lux lucens in tenebris". Both texts are by no means independent.

Up to now only few attempts have been made finding out if it is possible to work out the underlying chemistry of the synthesis of Mercurius Solis preparations from the sparse hints given in the literature. Following a recipe of „Lux in tenebris lucens" the preparation is as follows: Gold is dissolved in aqua regia. Yellow tetrachloroauric(III)-acid is produced. After cooling, crystals of goldtrichloride appear. During further heating decomposition processes can be observed and after the addidion of a reducing agent manyfold coloured colloidal gold solutions appear. Still in our days research on colloidal gold chemistry is a fascinating task.

Keywords

Paracelsianism, Mercurius Solis, aurum potabile, colloidal gold

Introduction

Treatises and reports of the late sixteenth and early seventeenth centuries testify that prominent alchemists of that time prided themselves on the preparation of a substance called *Mercurius Solis* ('Mercury of the Sun', i.e. gold). In a letter dated 6 April 1572, Count Felician von Herberstein wrote to Count Boldizsár Batthyány about a mysterious substance called *Mercurius Solis* in the context of alchemical fraud. Herberstein warned the addressee of the letter to be cautious. Liquid mercury should not be used in the course of the synthesis of *Mercurius Solis*. He recommended a *mercurius ex sole*: "If you want to work out something from metals your laboratory assistant should extract the soul from the gold."[1]

The famous physician Johannes Agricola tells us in 1638: "The whole world is talking about Mercurius Solis. There is no laboratory assistant who does not speak about this Mercurius."[2] In his youth Agricola was the assistant of Emperor Matthias's court physician in Vienna and was in touch with alchemists who had worked at the famous laboratory of Emperor Rudolf II in Prague. In Rudolf's laboratory at the Hradschin, immense sums were spent to obtain *Mercurius Solis*:

> Emperor Rudolf spent more than 10 000 ducats for this Mercurius, but the benefit was not even 1 ducat. Furthermore this Mercurius was not useful for a faster healing of the syphilis, which was widespread in those days in Prague.[3]

Agricola adds to the lamentation about *Mercurius Solis:*

> No subject under the sun causes more labour than *Mercurius Solis*. Many alchemists are of the opinion that they are on the right path when they can produce *Mercurius*

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[1] "Wildu aber was in metallicis operiern lassen so lass dein laboranten animam ex auro schaiden…" Dóra Bobory, personal correspondence, 28 Oct. 2009. For information about Felician von Herberstein, see Dóra Bobory, *The Sword and the Crucible: Count Boldizsár Batthyány and Natural Philosophy in Sixteenth-Century Hungary* (Newcastle upon Tyne: Cambridge Scholars, 2009), 64; 80ff. All translations are mine unless otherwise indicated.

[2] "Von dem Mercurio Solis und den andern Metallen singet fast die ganze Welt, und ist kein Laborant, der nicht von diesem Mercurio rede." Johann Agricola, *Chymische Medicin*, Vol. I (Leipzig 1638/39), 107a; O. Humberg (ed.), *Johann Agricola Chymische Medicin. Nach der Erstausgabe 1638/39* (Buchverlag O. Humberg: Elberfeld, 2000), 108f.

[3] "Bei Kaiser Rudolfo secundo hochlöblichster Gedächtnis weiß ich, dass über 10 000 Ducaten sind auf diesen Mercurium spendiert worden und ist nicht vor 1 Ducaten Nutzen daraus erfolget, ohne dass man die Franzosen, welche dazumal zu Prag sehr gemein gewesen, damit geschwinder curieren könne." Johann Agricola, *Chymische Medicin*, Vol. I (Leipzig, 1638/39), 108.

Solis, since all philosophers attest that the beginning of the work should be extracted from sun beams as Sendivogius says… This judgement has caused so many alchemists to make fools of themselves. Their brains have been sublimated like mercury and they have been ruined as if they dissipated into the air.[4]

Experiments at the Imperial Laboratory in Prague

It is clear that Emperor Rudolf II was trying hard to produce *Mercurius Solis*.[5] The archive of Litoměřice contains a letter by Rudolf to Wilhelm von Rosenberg,[6] dated 27 October (no year given – but it can be assumed that the letter was written in 1589),[7] in which the Emperor asks his friend Wilhelm to temporarily release "Eduardus" (the alchemist Edward Kelley) from his work, since a major alchemical process requires his oversight. Rudolf mentions that the operation is extremely difficult, and cannot yet be perfected, as the *Mercurius Solis* is missing: "the most important piece is missing: the Mercurius Solis. Without it, the process cannot be performed. Therefore I recommend that Edward should come here to remedy this shortcoming."[8]

It was an open secret that Edward Kelley, who worked for the emperor from 1589 to 1591, could produce *Mercurius Solis* with the help of a special tincture within a quarter of an hour. A manuscript at the Austrian National Library is titled *Operationae alchymicae traductae in hanc brevitatem per E. K.* [i.e. Edward Kelly], with the incipit: "Lapis de Mercurio Solis et Lunae" (MS 11,526, ff. 254–277). Matthäus Erbinäus von Brandau,

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[4] "Ist ein Subjectum unter der Sonnen, das den Alchemisten mehr Arbeit macht, so ist es dieses, und vermeinen ihrer viel, wenn sie nur den Mercurium Solis machen könnten, so wären sie auf dem rechten Wege (…), weil die Philosophi alle einhellig bezeugen, dass der erste Anfang des Werkes (…) sollte aus den Strahlen der Sonnen, wie Sendivogius vermeldet, gezogen sein. Dieses Dictum hat ihrer soviel zu Narren gemacht und ihr Gehirn dermaßen sublimiert, dass sie neben ihm, Mercurio scilicet, zunichte wurden und in die Luft aufgangen." Ibid.

[5] R. W. Soukup, "Transformování celého Corpus Solis v Liquorus Irreducibilis. Laboratorní alchymie na dvoře císaře Rudolfa II," in Ivo Purš & Vladimir Karpenko (eds.), *Alchymie a Rudolf II* (Prague: Artefactum, 2011), 216. For an English translation of this chapter, see R. W. Soukup, "Transforming the Whole Corpus Solis into a Liquorem Irreducibilem," in Ivo Purš & Vladimir Karpenko (eds.), *Alchemy at the Court of Emperor Rudolf II* (forthcoming).

[6] Wilhelm von Rosenberg (1535–1592) was Supreme Burgrave and the most important magnate in the kingdom of Bohemia. Heinrich Khunrath was one of his alchemists in Krumlov. See: R. J. W. Evans, *Rudolf II. Ohnmacht und Einsamkeit* (Graz: Styria, 1980), 330ff.

[7] See: Evans 1980, op. cit, 143ff.; R. W. Soukup, *Chemie in Österreich. Bergbau, Alchemie und frühe Chemie* (Wien: Böhlau-Verl. 2007), 363.

[8] "... das Höchstück darzu mangelt, der mercurius solis, an [sic]dem die sach nit kan verfertigt werden, halt derhalben für guet das der Eduard derselbst hieher khamb, disem manglen zu helffen." (Evans 1980, op. cit., 151)

alchemist, physician and Bohemian knight, reports extensively on the emperor's alchemical activity, claiming that the emperor obtained his own tincture:

> The Hermes Trismegistos of our time, Emperor Rudolf II, was not only an adept of the true imperial art, he had seen some of the species and succeeded in the preparation of a tincture by himself, which was estimated to represent a value of 40,000 ducats.[9]

The ingredients for this tincture must have cost a fortune. Erbinäus von Brandau described how Rudolf II used to keep the product in a special silver canister covered in red velvet. He believed that the tincture was stolen by the secret imperial valet Caspar Rutzky von Ruz ("Rutzken") after the emperor's death.[10] The tincture – said to be of grey colour and very heavy – was found in Rutzky's house and given back to the legitimate heir Emperor Matthias. Rutzky later hanged himself in prison:

> His Majesty used to carry this (tincture) in a great box made of silver sheet and covered in red velvet. After the death of His Majesty this tincture was stolen by the imperial valet Rutzken, who later hanged himself. Nevertheless the tincture was discovered by N. N. in Rutzken's house and handed over to His Majesty Emperor Matthias. The person who has seen this tincture told me that it was of grey colour and very heavy, because of an improvement by mercury – the normal practice in this art.[11]

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[9] "Unser Zeit Hermes Trismegistus, Keyser Rudolphus II. Hochlöblichgen Gedächtnis/ hat diese rechte Keyserliche Kunst nicht um sonst geliebet: denn S(eine) M(ajestät) (hat) nicht öffters deren Specimina nur gesehen/ sondern auch endlich selbst eine Tinctur erlanget/ die man auff die 40000 Ducaten geschätzet." *Mattai Erbinäi von Brandau Wahrhaffte Beschreibung von der Universal-Medicin und Guldene Tinctur Ursprung … zu Druck befördert und communicirt durch T.P.G.L.M.S.* (Leipzig, 1689), 15f.

[10] In the Imperial Household Register of February 1612 the name is spelled as 'Caspar Ruzkhy vonn Stüz.' Furthermore, there is a note saying that he hanged himself in prison after the death of His Majesty: "Nota. Dieser hat nach Ihrer Khay: Mt: Hochseeligister Gedechtnuß etc. ableiben, inn der khüniglich[en] v[er]haftung Sich Selbst Erhenckt." Digital version: Documenta Rudolphina: http://documenta.rudolphina.org/Regesten/A1612-02-00-02640.xml (Last accessed on 10 Jul 2009).

[11] "Es pflegten Ir. Maj. dieselbe (Tinctur) bißweilen in einer Silbern breiten Blechbuchse zu tragen/ mit rothem Sammet überzogen/ ist aber von den [sic] Cämmerling Rutzken/ der sich selbst erhencket/ nach deren Keys. Majest. Absterben gestohlen worden (welche gleichwohl N.N. in des Rutzken Hause gefunden/ und Ihr. Keys. Maj. Matthias als rechtmäßigen Erben überantwortet). Der diese Tinctur gesehen/ berichtete mich [sic]: dass sie grau Aschefarbe/ und sehr schwer gewesen sey: von Auffrichtung mit Mercurio des ingresse wie in der Kunst Brauch ist." Documents of the Austrian State Archives (Österr. Staatsarchiv, Haus-, Hof- und Staatsarchiv) confirm the report of Matthäus Erbinäus von Brandau (HHStA, W 57 [Böhm 108] vol. 3, fol. 43r (H 21r) Documenta Rudolphina: http://documenta.rudolphina.org/Regesten/A1612-01-21-02620.xml (last accessed on 10 July 2009).

Comment on a Problem of Alchemical Terminology

It would be difficult to find an alchemist of the sixteenth or seventeenth century who never used the term "mercurius." However, the word had many different meanings. In a contemporary dialogue between the chemiatric physician Dr Alexander von Suchten[12] (A.) and his old fellow student Bernhardus (B.), published by Benedictus Figulus in 1608, this problem is picked out as the central theme. The tract, titled *Pandora Magnalium Naturalium aurea et Benedicta*, begins with a simple question about the importance of Mercurius Solis:

> Is it possible that Paracelsus has found the true medicine? He wrote so many nasty things and his pupils contradict another. One says that the most important substance is *antimonium*, another points to *mercurius solis*, a third to pearls and corals…[13]

Some pages afterwards we can read the following:

> *Alexander:* The philosophers say all metals are formed from Quicksilver. *Bernhardus:* That is false, for Quicksilver is a metal in gold as well as in silver, etc. But since it is a living metal, it is not recognized as a metal in high philosophy. *Alexander:* Since Mercury is the matter of metals, as you have just said, what sort of thing is Mercury? *Bernhardus:* Just the same as the substance out of which Quicksilver, Gold, Silver, Lead, Copper, etc., and our Medical Mercury, are made. *Alexander:* Has this matter no name? *Bernhardus:* The inventors of this Art have called it Mercury. Their successors, interpreting Magic literally have supposed Mercury to be nothing but Quicksilver, which is the opinion of all scribes to this day.[14]

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[12] Recently Oliver Humberg found that the famous Dr. Alexander von Suchten died in November 1575 as "Landschaftsarzt" in Linz in Upper Austria: O. Humberg, "Die Verlassenschaft des oberösterreichischen Landschaftsarztes Alexander von Suchten († 1575)," Wolfenbütteler Renaissance-Mitteilungen 31 (2007), 31–50. In his paper in this volume, "Antemurale alchimiae: Patrons, Readers, and Practitioners of Alchemy in the Polish-Lithuanian Commonwealth", Rafał T. Prinke points out the existence of a familiar relationship between Alexander von Suchten and Nicolaus Copernicus.

[13] "A. wie kan Paracelsus die wahre Arzney wider erfunden haben, dieweil Er so viel Widerwertiges dings geschriben, vnnd seine Discipuli der sachen selbst nicht Eins seind. Einer sagt, im Antimonio stecke die Kunst, der Ander im ☿☉, Perlen, und Corallen…" Benedictus Figulus, *Pandora Magnalium Naturalium Aureo et Benedicta, De Benedicato Lapidis Philosoph. Mysterio (*Straßburg, 1608), *Dialogus Alexandri a Suchten*, 64.

[14] "A. Die Philosophi sagen, daß die Metalla omnia auß Argento vivo seind geschaffen. B. Daß ist falsch, dann Argentum vivum ist eben so wol ein Metall in ☽ und ☉ &c. Dieweil es aber ein lebendinges Metall ist, wird er (sic) nicht für Metall gerechnet in Philosophia adepta. A. So Mercurius ist Materia metallorum, wie du jetzt gesagt hast, was ist dann Mercurius für ein ding? B. Eben dasselbige, darauß das Argentum vivum, Gold, Silber; Bley, Kupffer… Vnd unser Mercurius Medicus gemacht. A. Hatt dann diese Materia keinen Nammen? B. Die

Indeed, throughout the history of alchemy the term "mercurius" could mean:

1. First of all, the ordinary metal mercury, "quicksilver."
2. The god Mercurius (Hermes Trismegistus), patron of alchemy.
3. Special compounds of mercury, e.g. sublimate or calomel.
4. The mercuric nature of the substances, namely the metallic nature and metallic essence of all metals.
5. Last but not least, in the psychology of C. G. Jung, *mercurius* is the symbol of the arcanum, the ultimate (psychological) aim of the alchemical process.[15]

Bearing the manifold meanings of the term *mercurius* in mind,[16] we may take a closer look at some manuscripts of the sixteenth century.

Mercurius Solis in Manuscripts of the sixteenth Century

In 1570, the Paracelsian Dr. Johann Albrecht (c. 1539–after 1576), who worked as a physician at the Bavarian Court in Munich, praised *Mercurius Solis* exceedingly after he learned something of its preparation from the pseudo-Paracelsian treatise *De Tinctura Physicorum*:

> Theophrastus praises this medicine in all of his writings, especially in his booklet 'Tinctura Physicorum', ascribing to this medicine the healing of all serious illness. As I found out, this medicine is incredible powerful and it is nothing else than *Mercurius Solis* produced without any other metal than gold.[17]

Erfinder dieser Kunst habens Mercurium geheissen, die nach ihnen kommen, vnd die Magica nach dem Buchstaben verstanden, haben gemeinet, Mercurius sey nichts anderes dann Quecksilber, wie dann noch heutigen tags alle Schriftgelehrten meynen." Ibid., 107f.

[15] C. G. Jung, *Studien über alchemistische Vorstellungen*, Gesammelte Werke Vol. 13, 2nd ed. (Olten: Walter-Verl., 1982), 252.

[16] This problem is discussed in detail by O. Humberg, "Über den Mercurius metallorum," *Hermes* 21 (2002), 16–26: http://www.fk-alchemie.de/Hermes/index.html (accessed 10 July 2009).

[17] "…die artznej, welcher Theophrastus in allen seynen schrifften das grösste lob gibtt, … jr allain jm buechlein de tinctura physicorum aller schwerer kranckhaitten hailung, die Er vollbracht, zu schreibtt, Die Ich auch gebraucht, vnnd vnglaubliche krefften dorin befunden, Vnnd ist diese der Mercurius Solis, welcher on alle andere metall aus dem goltt beraytt wurdt,…" Letter to Kurfürst August von Sachsen 10 July 1570: W. Kühlmann und J. Telle, *Corpus Paracelsisticum.* Vol. II: Der Frühparacelsismus (Tübingen: Niemeyer, 2001), 999ff.

Nowadays there is no doubt that the pseudo-Paracelsian *De tinctura physicorum* was not written by Paracelsus himself. However, one can find a passage in the authentic Paracelsian book *De vita longa*, in which Paracelsus praises "Mercurius Solis" and "Mercurius Lunae" as medicines for leprosy. Paracelsus notes, "This is the work and this is the performance: After all, this Mercurius is, of course, no tincture of metals, but in the [human] body it is able to restore health."[18]

An authentic fragment belonging to the *De vita longa*-corpus, written originally in German, seems very interesting to me, with respect to similar declarations in pseudo-Paracelsian tracts:

> Of all elixirs, *aurum potabile* is the best. All processes can be understood by this very process. Since gold performs its effect not without a corrosive, it follows that its solution must be decomposed.[19]

A quote in the pseudo-Paracelsian treatise *Lux in tenebris lucens* refers to this passage in the authentic text of Paracelsus. And what is even more interesting: the whole treatise *Lux in tenebris lucens* is dedicated to the preparation of "Mercurius Solis." Benedictus Figulus edited this treatise in 1608 in German.[20] He used a translation made by the Tyrolian Paracelsian Adam Haslmayr in Schwaz. Haslmayr tells us that he received the treatise from

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[18] "Hoc opus, hic labor est, vt Mercurium (Solis) exacte conficias. Postremo etsi Mercurius ad tingenda metalla non prorsus sufficere: valeret tamen in corpore, vt illud sanitate restitueret." Theophrastus Paracelsus, *De Vita longa, breui, et sana … vero opera et studio Gerardi Dornei Commentarijs illustrati* (Frankforti: Christoff Rab, [DATE?]), Lib. II, Cap. IIII (*De Lepra*), 80.

[19] "Caput tertium, de auro potabili. Under allen elixir ist aurum das höhest und das merest für uns zu nemen. Dan(n) durch den selbigen prozeß werden alle prozeß verstanden, … das(s) goldt on corrosivo kein wirkung vollbringen mag … auf das folgt, das(s) die resolution wider hindan putreficirt sol werden." Theophrast von Hohenheim gen. Paracelsus, *Sämtliche Werke* hrsg. von Karl Sudhoff, Medizinische, naturwissenschaftliche und philosophische Schriften, Bd. 3, 303.

[20] Benedictus Figulus, *Thesaurinella Olympica aurea tripartita. Das ist: Ein himmlisch güldenes Schatzkämmerlein III. Lux in tenebris lucens Raymundi Lullii: Wie die höchste Geheimnuß der Natur zu erforschen …* (Frankfurt: Wolfgang Richter, 1608), 108ff. The book was dedicated to Johann Baptist von Seebach, imperial valet of Rudolf II in Prague from 1595 to February 1612. The dedication says that Seebach was very experienced in the spagyric art (see: http:/documentarudolphina.org/Regesten/A1612-02-00-02757.xml). Further editions of the text are: J.P.S.M.S. (M. Sendivogius), *Alchemia Vera* (Erfurt, 1604), 8–112 (a short version); *Promptuarium alchemiae Ander Buch* (Leipzig, 1614), 169–258; *Thesaurinella Olympica Aurea Tripartita … anjetzo eröffnet und publicirt durch Benedictum Figulum* (Frankfurt, 1682), 142ff. *Neue Sammlung von einigen alten und sehr rar gewordenen Philosophisch und Alchemistischen Schriften als eine neue Fortsetzung des bekannten deutschen Theatri Chymici*, II. Theil (Frankfurt and Leipzig, 1770), *Lux in tenebris lucens Raymundi Lulli … publicirt d. Benedictum Figulum…,* 81–140.

Lurenz Lutz, a former famulus of Paracelsus, living in Algund near Meran in South Tyrol. As Johannes Agricola reports, Adam Haslmayr was not only interested in theoretical alchemy, but also in its practice. In 1611, he possessed "nearly one pound, half a kilogram, of Mercurius Solis" ("fast ein Pfund mercurium Solis").

It is well known that another treatise with a similar title exists, namely the *Lux lucens in tenebris*. A manuscript version of this text at the Staatsbibliothek Hamburg was edited in 2006.[21] The editor, H. G. Lenz, believes that Heinrich Khunrath was the author of this manuscript.[22] I disagree. In my opinion, both texts are by no means independent. They stem from the same source. Compare, for instance, the two following passages:

Lux in tenebris lucens (132, line 11ff)	*Lux lucens in tenebris* (f. 6b)
So nun/ wie gemeldet/ alles verrichtet/ vnd die Materia in jhrem Philosophischen Vaporischen Fewer gebürlich gehalten wirdt/ erfolget eygentlich/ wie die Philosophi bezeugen/ vnd die Erfahrung mit bringt/ die Solutio Mercurii in Aquam, doch durch keinen anderen Weg oder Mittel/ dann in Gestalt vnd Form eines natürlichen Taws/ welcher sich dann im Glaß hin vnd her Tropffenweiß anhängt/ vnd sich letzlich in ein Wasser resoluirt/ welches doch gleichwol nit/ wie gemein Wasser zusammen fleust/ sondern als ein Vapor vnctuosis stehet…[23]	So nun alles wie erzählet geschicht und die Materia im philososphischen und dunstigen Feuer gehalten wird, erfolget die Solution (doch in keiner andern Form als in Gestalt des natürlichen Taues, welcher sich im Glase hin und wieder tropfenweise anhänget, auch letzlich zu einem Wasser verändert, und doch nicht wie ander gemein Wasser fleußet, sondern als ein feister Dunst...

[21] Codex alchimicus 674 Staatsbibliothek Hamburg: H. G. Lenz (Hg.), *Der Alchemist Conrad Khunrath* (Verl. O. Humberg, Elberfeld 2006), 107ff.

[22] The alchemist Rudolph Friedrich Johann Schmid (1702–1761) was a former owner of the manuscript. He wrote on the first page: "Henrici Khunrat Lipsiensis Tractatus quem Lucens lucentem in Tenebris vocavit." The person who made the copy noted: "Ich hatte in meinem Besitz ein kleines Einführungswerk in deutscher Sprache, 'Lux Lucens in tenebris' von Herrn Heinrich Khunrath aus Leipzig..." ("I was in the possession of a small introduction in German, 'Lux Lucens in tenebris' from Heinrich Khunrath from Leipzig.") A variant of the text was printed in 1677 in Bautzen under the title *Lucens Lux in tenebris* (*Vier chymische Tractätlein*).

[23] "Since all is done as described before and the material is heated on the philosophical vaporous fire, the solution of mercury in 'water' takes place, as the philosophers testify and experience confirms. This *mercurius* occurs in the form of natural dewdrops in the glass. It resolves not like normal water but stands still like an oily vapour."

Both texts are, at this point, nothing else than two different translations of a Latin original. Since an unknown writer remarked on the first page of *Lux lucens in tenebris*: “Vidi latinum Mscr. de Ao 1514 Coloniae”, it is evident that the original version was compiled before 1514.[24]

Both texts describe how the substance is dissolved in *aqua* (*regia*) and then heated, and use similar descriptions of phenomena. In *Lux in tenebris lucens* we hear of “macherley Farben/ die sich wunderbarlich verändern/ wunderbarlich einander folgen” (“all sorts of colours, amazingly changing and following each other”), and “Sternlein im Glase, die balde vergehen und andere an die Statt kommen” (“tiny stars fading away and being replaced by others”), while *Lux lucens in tenebris* describes “mancherley farben Sternlein / die verleschen vnd widerumb erscheinen” (“tiny stars fading away, new ones coming instead”). Important is the hint: “the material is converted into a yellow-brown oil, glowing metals pushed into it are transformed into gold.”[25] After the *nigredo* and the *albedo* stages, everything reaches the state of the *rubedo*. In *Lux in tenebris lucens*, this is described as follows: “Nec deinde in diuersos colores variantur, praeterquam in rubeum, in quo vltimus est finis” (1608, 137, line 17ff); in *Lux lucens in tenebris:* “…und verändert sich nachmals in keine andere Farbe mehr, ausgenommen in die Röte, in welcher weiter das Ende ist (f. 9a/9b). (“And now it does not again change its colour, except into the Red, in which everything is coming to an end.”)

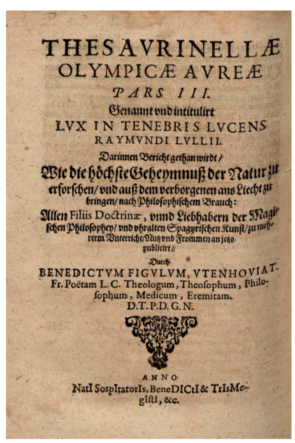
THESAVRINELLÆ
OLYMPICÆ AVREÆ
PARS III.
Genannt vnd intitulirt
LVX IN TENEBRIS LVCENS
RAYMVNDI LVLLII.
Darinnen Bericht gethan wirdt/
Wie die höchste Geheymnuß der Natur zu erforschen/ vnd auß dem verborgenen ans Liecht zu bringen/ nach Philosophischem Brauch:
Allen Filiis Doctrinæ, vnnd Liebhabern der Magischen Philosophey/ vnd vhralten Spagyrischen Kunst/ zu mehrerm Vnterricht/ Nutz vnd Frommen an jetzo publicirt/
Durch
BENEDICTVM FIGVLVM, VTENHOVIAT. Fr. Poëtam L. C. Theologum, Theosophum, Philosophum, Medicum, Eremitam.
D.T.P.D.G.N.
ANNO
NatI SospItatorIs, BeneDICtI & TrIsMegIstI, &c.

Fig. 1. Benedictus Figulus, *Thesaurinellae olympicae aureae pars III. (…) Lvx in tenebris lvcens Raymundi Lullii* (Frankfurt, 1608).

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[24] In the *Rosarium philosophorum*, which gives an insight into the alchemy of the fourteenth century, we cannot find the term, “Mercurius Solis,” but we can read something about “aurum potabile.” J. Telle, *Rosarium Philosophorum. Ein alchemisches Florilegium des Spätmittelalters* (Weinheim: VCH, 1992), Vol. 1, 11; Vol. 2, 16.

[25] “[D]ie materia ist in ein Citrinbraun Oel verwandelt worden/ vnd die glüenden Metallen darein gestossen in gut Gold transmutiret werden.” *Lux in tenebris lucens,* edition of 1608, 134

Chronological table

These findings enable us to trace the reception of the term 'Mercurius solis' as follows:

1514 Compilation of the Latin manuscript of *Lux lucens in tenebris.*

1562 *De vita longa* printed for the first time.

1570 Leonhard Thurneysser mentions Mercurius solis in chapter I of book IV of his compendium *Quinta Essentia.*

1570 Dr. Johann Albrecht praises Mercurius Solis after reading *De Tinctura Physicorum.*

1608 Edition of the treatise *Lux in tenebris lucens* by Benedictus Figulus.

1639 Print of Johann Agricola´s *Chymische Medicin*.

1689 Print of *Wahrhaffte Beschreibung von der Universal-Medicin* of Matthäus Erbinäus von Brandau

***Mercurius Solis* in the light of modern chemistry**

> In *Lux in tenebris lucens* we read that, "Mercurius Solis is contained inside gold, only the philosophers can get to the bottom of the secret." (edition of 1770, page 112). And further: "The art of extracting the Mercurius Solis remains the darkest secret to all philosophers (…) and so many went astray." (1770, 114).[26]

Following this account, *Mercurius Solis* is nothing else than than "the prime material of the Philosopher's Stone tincturing man and metals" ("die prima materia Lapidis Philosophorum, zu tingiren den Menschen und die Metalle"). Indeed, this *Mercurius Solis* is praised, on the one hand, as a panacea against all sorts of disease (especially against "Melancholie und Wahnsichtigkeit") and, on the other, as a gold-producing tincture. The recipe is as follows:

[26] „Der Mercurius Solis ist dem Gold also innerlich eingeleibet, das er von keinem als den Sapientibus erkennet werden kann." *Lux in tenebris lucens*, edition of 1770, 112 "… Darum dann auch diese Kunst den Mercurius Solis zu bereiten von allen Philosophis als das hochste je und allwegen verborgen worden, und ist derhalben nicht mit geringstem Fleiß, sondern auf das emsigst nachzugründen, wie doch solches Werk möge vollbracht werden, dann viele irrige Weg hierinn gefunden, welche nicht zum gewünschten Ende führen, sondern abweisen zum Verderben... " (Ibid., 114)

> At first, dissolve fine gold - which was purified to the highest degree by aqua fortis or by antimonium - in his own "water." The plegmatic part of the liquid is removed down to an oily consistence and the solution stored at a cool and humid place until crystals appear. These crystals are exposed to putrescence and sublimation to be ennobled into vivid mercurius. (*Lux in tenebris lucens*, edition of 1770, 114)[27,28]

Up to this point, the procedure is comprehensible in modern chemical terms:[29] gold is dissolved in *aqua regia*. *Aqua regia*, a mixture of hydrochloric and nitric acids, contains nitrosylchloride and atomic chlorine. Yellow tetrachloroauric(III)-acid is produced.

$$Au + NOCl + 2\ Cl + HCl \rightarrow HAuCl_4 + NO$$

When the solution is heated, water and volatile components of the acid are removed. After cooling, crystals of gold trichloride $AuCl_3$ appear:

> When the water is becoming more and more thick, stops evaporating, remains almost still and is moving leisurely in the lower part of the vessel, it starts to develop into an incombustible oil of citric-brown colour. This oil can be used as a tincture. When putting glowing silver into it, the metal soon gets transformed into gold. (*Lux in tenebris lucens*, edition of 1770, 127f)[30]

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[27] "Erstlich, sollst du fein Gold durch die Quartio oder "Antimonium" zum allerhöchst gereiniget solvieren in seinem eigenen ´Wasser´. Alsdann die Phlegma abgezogen, bis auf die Olität, soll die Solution, samt der Olität in ein kühls und feuchts Ort gesezt werden, so lang bis das solvirt Gold zu Chystallen scheust, welche, nachdem sie erscheinen, sollen sie durch gebürliche Mittel der Putrefaction und ´Sublimation´ in ein lebendigen Mercurium verwandelt werden."

[28] A very similar recipe can be found in the second edition of Libavius's *Alchymia* (Frankfurt, 1606), 235, where Libavius quotes Bernard Georges Penot, a Paracelsian physician from Aquitaine. Penot speaks about the solution of gold in *aqua regia* and of the formation of crystals after distilling and cooling the solvent (*Theatrum chemicum*, vol. 2, 1602, 155). The crystals should be heated in a "sublimatorium," and "es wird ein sehr schönes Pülverchen von gelber Farbe aufsteigen."

[29] In his paper „Chemical Translation and the Role of Impurities in Alchemy: Examples from Basil Valentine´s Triumph-Wagen" Lawrence Principe pointed to fact that the translation of an alchemically described process into modern chemical terms is always problematical (*Ambix* 34 (1987), 21-30). Obviously, the presence of unsuspected impurities may lead to unexpected products. This methodological caveat was taken in consideration especially in the following chapters of this paper, since it is known that when colloidal gold is produced impurities may form an adsorption layer around these colloids (see: W. Caseri, „Nanocomposites of Polymers and Metals or Semiconductors: Historical Background and Optical Properties", Macromolecular Rapid Communications 21 (2000), 706).

[30] "Wo dann nun also das Wasser anfanget dicker zu werden/ und nicht mehr vapororisch aufsteigen/ sondern stiller zu stehen/ und sich gemächlich in den unteren Theil der Sphaera zu bewegen/ so gehts in ein Oel/ welches dann rechte Oleum incombustibile an der Farb citrinbraun ist/ und wann man will/ so ist es zu einer Tinctur

The yellow "Oleum incombustibile" reacts with silver in the form of a cementation reaction:

$$AuCl_3 + 3\ Ag \rightarrow Au + 3\ AgCl$$

During the heating process the decomposition of $AuCl_3$ (present in excess) takes place:

$$AuCl_3 \rightarrow AuCl + Cl_2 \text{ (above } 150^oC)$$

Not only may the occurrence of a yellow gold(I)-chloride[31] be observed, but also that of gold(I,III)-chloride. Gold(I,III)-chloride is a claret-red, nearly black solid of the chemical formula Au_4Cl_8, that contains gold in two different oxidation states: +1 and +3. Au_4Cl_8 is photosensitive.[32]

During further heating, AuCl decomposes: $2\ AuCl \rightarrow 2\ Au + Cl_2$

Normally one can now observe the formation of very small golden crystals – like tiny stars. The author of the *Lux lucens in tenebris* reports that a thin film grows on the surface of the *oleum*, which precipitates as a yellow sand on the bottom of the flask (f. 8b).

Thinking about the grey and very heavy 'tincture' of Emperor Rudolf, such specifications point towards the assumption that this grey matter was a mixture of powdery aurous chloride (AuCl), gold oxide, and grey amorphous colloidal gold. By adding an alkaline solution to the heating product of gold chloride, such a mixture with a rather high density can be obtained.

The Many-coloured Solutions of Colloidal Gold

In classical alchemy the play of colours was an essential part of the game. The most important step was the *nigredo*, when everything was black, often called also *putrefactio*.

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bequem. Dann so man ein glueend Silber oder Silberblech darein stecket/ so wird solches alsbald in gut Goldt verwandelt..."

[31] $\rho = 7{,}4\ g/cm^3$.

[32] See: http://en.wikipedia.org/wiki/Gold%28I,III%29_chloride. Au_4Cl_8 decomposes at 254^oC, $\rho = 3,9\ g/cm^3$. It is soluble in ether.

Within the framework of gold chemistry this could equate to the stage when gold(I,III)-chloride is formed or – perhaps after addition of a reducing agent or in the presence of impurities – when gold precipitates as a bluish or even black colloid in the elemental state.

Elemental gold is able to occur in different colours: ruby, purple, blue, black (fig. 2). It depends only on the diameter of the particles.

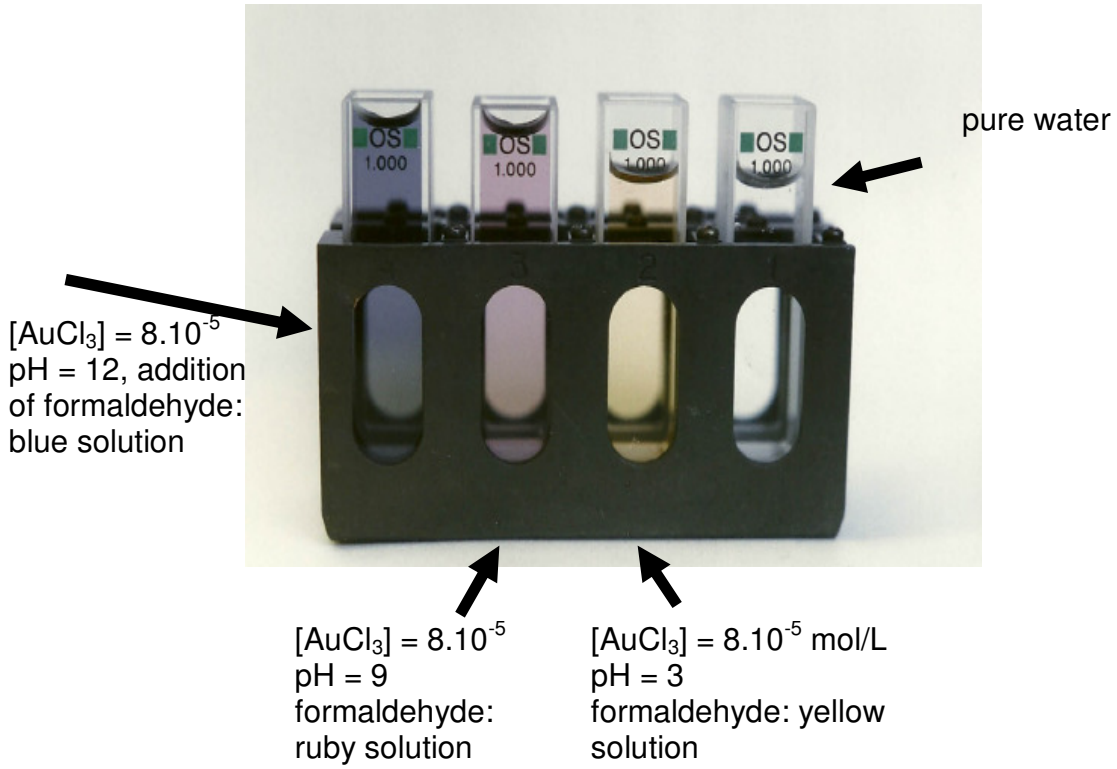

Fig. 2. Solutions of colloidal gold after the addition of formalin to gold solution at different pH values.[33] (Photography R. W. S.)

It is remarkable that solutions of colloidal gold – the old "Trinkgold" (drinkable gold) of the age of Paracelsus – remain very popular in contemporary complementary medicine.[34]

[33] T. Stojakovic, "De altera facie auri", *Fachbereichsarbeit GRG3* (Vienna, 1994).

[34] S. Suroh and A. Thrietur, „Das Trinkgold der Alchemisten – Aurum Potabile, ein mittelalterliches Geheimnis wurde wiederentdeckt", Medizin 2000, 8 (2001), 62f.

The Enigma of the Additive

Most alchemical texts conceal the reducing agent in this crucial step in the process. It is possible that the process takes place without a reducing agent, with heating alone. But the process would be enhanced when a reducing agent (such as alcohol) is present.

The treatise *Lux lucens in tenebris* reveals what should be added: "Convert these crystals into a mercury by decomposition and by additives as you know. In this way you have broken the CORPUS SOLIS for the first time and you have changed it into the PRIMA MATERIA."[35] Some lines below, it is stated that the additive is not metallic mercury.

In a paper published online,[36] Eric Vandenbroeck proposed to exclude all substances by the means of a *via negativa procedure*. He mentions that Andreas Cassius (†1673) in "De Auro"[37] was the first to uncover what had been a carefully guarded alchemical secret. In 1766, in his dictionary entitled *De Chymie*, Peter Macquer (1718–1784) mentioned alchemists who dissolved gold in *aqua regia*, added ethereal oils, separated the latter from the acid and mixed it with alcohol; by doing so, Macquer wrote, these charlatans claimed not only to have dissolved the gold fundamentally, but also to have obtained a medicine with remarkable healing abilities. These gold tinctures – often called *aurum potabile* – were nothing other than natural gold, most finely dispersed and floating about in an "oily" fluid. Hints given in Heinrich Khunrath´s (1560–1605) treatise *Vom Hyleatischen Chaos* in connection with the "universal mercury", namely that this Mercurius is "volatile to that point that it readily evaporates without the application of heat",[38] leads Vandenbroeck to the assumption that even at the end of the sixteenth century alchemists were working with diethylether.

There is evidence that Paracelsus himself knew ether very well. Paracelsus said that he produced a mixture of alcohol and sulphuric acid. The distillation product of that mixture makes hens fall asleep for some time. They wake up again later without any harm. This

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[35] "Diselben Cristallen mache durch gebührliche Putrefaction und zugethane Mittel zu einem Mercurio, wie dir bewusst, so hast das CORPUS SOLIS das erste Mal gebrochen und in die erste MATERIAM gebracht…" (4b).

[36] Eric Vandenbroeck, Overview of Paracelsianism: http://www.world-news-research.com/EuroAlchemy2.html (last accessed 26 June 2011).

[37] A. Cassius, *De Extremo Illo Et Perfectissimo Naturae Optificio Ac Principe Terraenorum Sidere Auro* (Hamburg: Wolffen 1685), 97.

[38] „… dermassen flüchtig verhanden, dass, so es an der Lufft offen stehet, von sich selbst, ohne antreiben des äusseren Feuers, in den Lufft verrauchet hinweg fleucht und verschwindet, …" H. Khunrath, *Vom Hyleatischen, das ist Pri-Materialischen Catholischen oder Allgemeinen Natürlichen Chaos* (Frankfurt: Oehrling, 1708), 137.

substance – as Paracelsus claims – "calms down all sorts of pain without harm, extinguishes all sufferings."[39]

In 1730, Sigismund August Frobenius (†1741), a German chemist working in Robert Boyle's laboratory in London, described the remarkable properties of *spiritus vini aethereus* in the *Philosophical Transactions of the Royal Society*. Frobenius, who his contemporary Cromwell Mortimer claimed had obtained his knowledge from an unnamed nobleman in Vienna, spoke about the wonderful harmony between gold and ether. He discovered the solubility of $AuCl_3$ in ether:

> If a Piece of Gold be dissolved in the best *Aq. Regia*, and upon the Solution Cold, be poured half an Ounce, or what Quantity you please of the Æthereal Liquor, shake the Glass carefully, and all the Gold will pass into the Æthereal Liquor …. The Experiment deserves the utmost Attention; for here the heaviest of all Bodies, Gold, is attracted by this very light Æther… owing to a certain Harmony and Similitude of both of them.[40]

As Claus Priesner has already suggested,[41] it is possible that Frobenius actually followed his alchemical predecessors, who identified diethylether as the pure shining fifth element of Aristotle. For Heinrich Khunrath, this ethereal substance is identical with the mercury of the philosophers, out of which the Philosophers' Stone is to be made.

Variants of the Process

Johannes Agricola described a variant of the procedure of producing *Mercurius Solis*:

> Take these crystals, add 2 lot of urinary salt, 1½ lot alkaline salt, 1½ lot tartar, and 1½ lot sublimated sal ammoniac and putrefy this for 14 days. Add half a pound crude

[39] "[S]edirt on schaden alle dolores, extinguirt alle passiones." Paracelsus, *Liber praeparationum*, ed. Sudhoff 3, 341; Paracelsus, *Buch von den natürlichen Dingen*, ed. Sudhoff 2, 133, 154.

[40] S. A. Frobenius, "An account of a *Spiritus Vini Aethereaus*," *Philosophical Transactions of the Royal Society* No. 413, 285-286. See: Walter Sneader, *Drug Discovery. A History* (Chichester: Wiley & Sons, 2005), 79.

[41] C. Priesner, "Spiritus Aethereus – Formation of Ether and Theories on Etherification from Valerius Cordus to Alexander Williamson," *Ambix* 33 (1986), 130ff.

tartar and sublimate or drive all through a retort into a receiver filled up with water, wherein the crystals come to life.[42]

Adding alkaline substances to solutions of auric chloride gold(III)-hydroxide $Au(OH)_3$ results in a precipitate. On heating, this substance loses water resulting in gold(III)-oxide Au_2O_3. Gold(III)-oxide is an intense red to brown solid substance – almost black. One has to keep in mind that under special circumstances the yellow sodiumtetraaureat $Na[AuCl_4]$. 2 H_2O can also occur, and that in the case of impurities being present, gold colloids may result as well.

Some alchemists believed that normal mercury should be added to the solution of auric chloride. Johannes Agricola published a recipe of *Mercurius Solis* in which goldtrichloride has to be heated together with antimonytrichloride. After a cementation reaction a golden ring ("ein güldener Ring") can be seen in the vessel, then the recovered gold should be amalgamated with liquid mercury. Agricola, however, remains sceptical. His comment reads as follows, "…it is believed that the gold has been transformed IN PRIMAM MATERIAM – I myself cannot believe that as the gold has first been transfomed IN SECUNDAM MATERIAM".[43]

In 1828, in his *Repetitorium der Pharmacie*, volume 29 a certain Dr. A. Buchner summed up all those trials:

Paracelsus propagated his Mercuris Solis as a panacea. His followers limited the use of this substance as a medicine against syphilis. Afterwards people learned that the healing power of mercury can be achieved without amalgamation with gold – as Paracelsus said. It operates in various compounds. It is not necessary to mix it with a precious additive.[44]

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[42] "… Diese (Kristalle Goldchlorid) nimm heraus dazu setze 2 Lot Salis Urinae, Salis Alkali, Salis Tartari et sublimati harmoniaci jedes 1½ Lot, laß es miteinander putreficieren 14 Tage. Danach schlage ihm ½ Pfund Tartari crudi zu und sublimiere oder treibe es durch eine Retorten in eine Vorlage, darinnen kalt Wasser vorgeschlagen ist, welcher sich in dem vorgeschlagenem Wasser lebendig machet…" *Chymische Medicin*, 111b.

[43] "…so hält man dafür, das das Gold wieder IN PRIMAM MATERIAM gebracht sei, ich kann es nicht glauben, denn das Gold ist allererst IN SECUNDAM MATERIAM gebracht." Johann Agricola, *Chymische Medicin* (1638), vol. I, 107.

[44] "Paracelsus hatte sein Mercurius solis als Universalmittel empfohlen; seine Nachfolger aber beschränkten den Gebrauch dieses Präparates mehr auf die Anwendung gegen das syphilitische Uebel; und nach und nach lernte man einsehen, dass das Quecksilber auch ohne es ehevor mit Gold zu amalgamieren, wie Paracelsus es gelehrt hatte, in seinen verschiedenen Verbindungen die gewünschte Wirkung thue, man ließ daher den kostbaren

Nanochemistry of Gold: Contemporary Research

For centuries, the conclusion of the alchemical process was characterized as the appearance of a ruby red colour, the *rubedo*. Gold salts react with nearly all kinds of organic material (e.g. ether) to reveal ruby red coloration: these are colloidal Au-clusters.

The very first record of an awareness of colloidal gold that I have found occurs in the third treatise of Stephanos of Alexandria, dating to the seventh century. An "ethesial lapis" is mentioned in connection with this substance:

> That is the etesial stone: It has many names. It is the porphyry, which is found in golden purple, it is that purple coloured matter, which is made of tin.[45]

In 1612, six volumes of the work entitled *L'arte vetraria* written by Antonio Neri were printed in Florence. The production of gold ruby glass is only suggested in this book. In 1684, Johann Kunckel learned about the *Praecipitatio Solis cum Jove*: that is, the precipitation of gold with the help of tin(II)-chloride.[46]

Michael Faraday was also fascinated by the ruby colour of gold solutions. In 1857, he published his paper "Experimental relations of gold to light" in the *Transactions of the Royal Society*. Faraday's original gold colloids were very stable and at least one example survived until World War II.[47]

The Nobel laureates of 1925 and 1926, Richard Zsigmondy and Theodor Svedberg, recognized the *aurum potabile* preparations of Paracelsus, Basilius Valentinus and all the other alchemists and pharmacists as colloidal solutions. In 1982, chemist Günter Schmid from

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Zusatz weg." A. Buchner, "Versuch über einige Verbindungen des Goldes, nebst theoretischen Folgerungen aus denselben" in: A. Buchner (editor), *Repetorium für die Pharmazie*, Bd. 29 (Nürnberg: Schrag 1828), 4f.

[45] "Das ist der etesische Stein: Dieser hat viele Namen, es ist der Porphyr, der im Goldpurpur gefunden wird, ist jene purpurfarbene Substanz, die aus Zinn gemacht wird…" R. W. Soukup, "Natur, du himmlische! Die alchemistischen Traktate des Stephanos von Alexandria. Eine Studie zur Alchemie des 7. Jahrhunderts," *Mitteilungen der Österreichischen Gesellschaft für Geschichte der Naturwissenschaften* 12 (1992), 1–93, esp. at 45; see also Taylor, "The Alchemical Works of Stephanos of Alexandria," *Ambix* 1 (1937), 30ff., 116ff.; *Ambix* 2 (1946), 177ff.

[46] W. Spiegel, "Johann Kunckel und die Erfindung des Goldrubins." See http://www.glas-forschung.info/pageone/pdf/ruby_01.pdf (4; last accessed on 5 June 2010).

[47] D. Thompson, "Michael Faraday's Recognition of Ruby Gold: the birth of Modern Nanotechnology," *Gold Bulletin* 40/4 (2007), 267–269: http://www.goldbulletin.org/assets/file/goldbulletin/downloads/Faraday_4_40.pdf

the University of Essen discovered the first gold-55-cluster-complex $Au_{55}(PPh_3)_{12}Cl_6$ (see fig. 3). In this case, tetraphenylphosphine and chlorine ions act as ligands.[48] Only a few years ago, developments within this field of research became turbulent. A huge number of gold clusters were characterized: Au_{16}, Au_{17}, Au_{18};[49] Au_7, Au_{19}, Au_{20};[50] and Au_{102}.[51] The properties of these substances are now discussed in regard to very special utilization in nanotechnology. Even today, the chemistry of gold remains a fascinating conundrum.

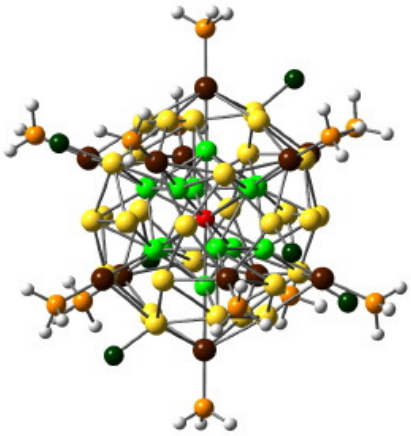

Fig. 3. Drawing from: G. Periyasamy and F. Remacle, "Ligand and Solvation Effects on the Electronic Properties of Au_{55} Clusters: a DFT Study", *NANOLETTERS* 9/8 (2009), 3007ff. http://www.moloc.ulg.ac.be/images/article/47_au55nl09.jpg (last accessed on 26 August 2010). By permission of the American Chemical Society: 30 August 2010.

Acknowledgement

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[48] G. Schön, "Die kleinsten elektronischen Schalter – Cluster aus 55 Goldatomen," *Spektrum der Wissenschaften*, April 1994, 22f.

49 S. Wang, "Au16, the smallest hollow gold cluster." See http://www.physorg.com/news66932851.html 16 May 2006 (last accessed on 25 May 2010).

[50] Ph. Gruene, D. M. Rayner, B. Redlich, A. F. G. van der Meer, J. T. Lyon, G. Meijer, A. Fielicke, "Structures of Neutral Au7, Au19, and Au20 Clusters in the Gas Phase," *Science* 1 (August 2008): http://www.innovations-report.de/html/berichte/biowissenschaften_chemie/bericht-115357.html 1 August 2008 (last accessed on 25 May 2010).

[51] Michael Walter et al. "A Unified View of Ligand-protected Gold Clusters as Superatom Complexes," *PNAS*, 105: 9157–9162; published ahead of print July 1, 2008. DOI: 10.1073/pnas.0801001105: http://www.sciencedaily.com/releases/2008/07/080714092749.htm (last accessed on 25 May 2010).