O P V S C V L A

A R C H Æ O L O G I C A

UDK 902-904 ISSN 0473-0992

IZDAVAČ / PUBLISHER
ARHEOLOŠKI ZAVOD FILOZOFSKOG FAKULTETA SVEUČILIŠTA U ZAGREBU
DEPARTMENT OF ARCHAEOLOGY, FACULTY OF HUMANITIES AND SOCIAL SCIENCES, UNIVERSITY OF ZAGREB

ADRESA IZDAVAČA / ADDRESS OF THE PUBLISHER
Arheološki zavod Filozofskog fakulteta
Department of Archaeology, Faculty of Humanities and Social Sciences
10000 ZAGREB – CROATIA
I. LUČIĆA 3 – P.O. BOX 171

RAČUNALNI PRIJELOM / COMPUTER LAYOUT
Ivanka COKOL for FF-press

PRIJEVOD NA ENGLESKI / TRANSLATION TO ENGLISH
Ana ĐUKIĆ & Vinita RAMLJAK

GODIŠNJAK / ANNUAL

Izdavanje časopisa novčano podupire
ODSJEK ZA ARHEOLOGIJU FILOZOFSKOGA FAKULTETA SVEUČILIŠTA U ZAGREBU
Publishing of the journal financially supported by
DEPARTMENT OF ARCHAEOLOGY, FACULTY OF HUMANITIES AND SOCIAL SCIENCES UNIVERSITY OF ZAGREB

Službena kratica ovoga časopisa je *Opusc.archaeol. (Zagreb)* / Official abbreviation of this journal's title is *Opusc.archaeol. (Zagreb)*
URL: www.ffzg.hr/arheo/opuscula

Dostupno na / Available at Ebsco Publishing (www.ebscohost.com)

Tiskano 2018. / Printed in 2018

OPVSC. ARCHÆOL. VOL. 39/40 STR. / PAGES 1–297 ZAGREB 2018.

OPVSCVLA ARCHÆOLOGICA

2018

OPVSC. ARCHÆOL. VOL. 39/40 STR. / PAGES 1–297 ZAGREB 2018.

FILOZOFSKI FAKULTET
SVEUČILIŠTA U ZAGREBU
FACULTY OF HUMANITIES
AND SOCIAL SCIENCES,
UNIVERSITY OF ZAGREB

RADOVI ARHEOLOŠKOG ZAVODA
PAPERS OF THE DEPARTMENT
OF ARCHAEOLOGY

UDK 902-904 ISSN 0473-0992

SADRŽAJ
CONTENTS

OPVSC. ARCHÆOL. VOL. 39/40 STR. / PAGES 1–297 ZAGREB 2018.

OPVSC. ARCHÆOL. VOL. 39/40 STR. / PAGES 1–297 ZAGREB 2018.

Zrinka BULJEVIĆ

ANASTASSIOS ANTONARAS, FIRE AND SAND. ANCIENT GLASS IN THE PRINCETON UNIVERSITY ART MUSEUM, PRINCETON UNIVERSITY ART MUSEUM SERIES, DISTRIBUTED BY YALE UNIVERSITY PRESS. NEW HAVEN AND LONDON, 2012.

doi: 10.17234/OA.39.16
Recenzija / Review

Primljeno/Received: 25.10.2014.
Prihvaćeno/Accepted: 5.3.2015.

Zrinka Buljević
Arheološki muzej u Splitu
Zrinsko-Frankopanska 25
HR-21000 Split
zrinka.buljevic@armus.hr

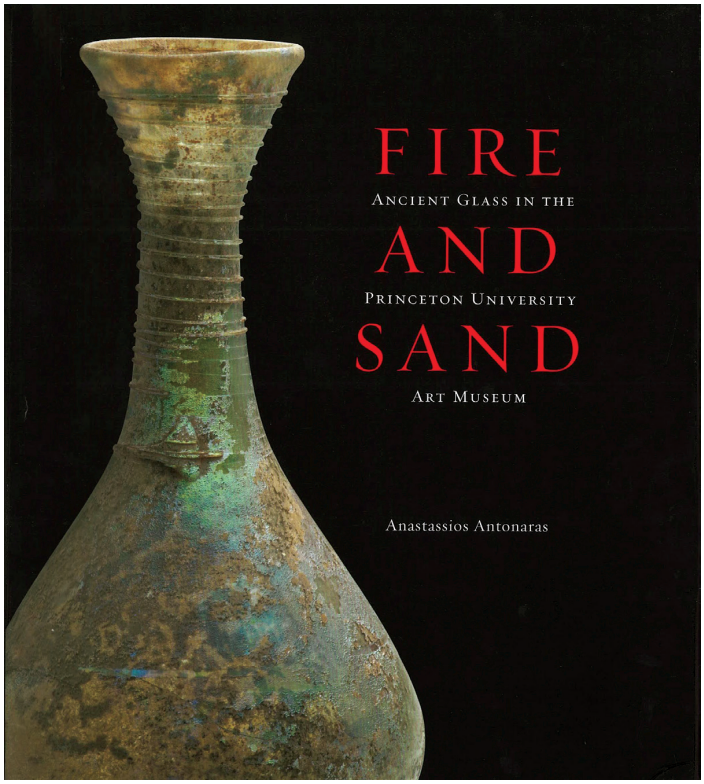
U ovoj se tvrdo ukoričenoj knjizi velikog formata (292 x 248 x 43mm), divot-izdanju tiskanom u siječnju 2013., na 408 stranica prvi put objavljuju gotovo svi antički predmeti iz zbirke Princeton University Art Museum, njih 509, mahom posuda ali i drugih staklenih izrađevina. Sakupljani preko sto godina potječu s lokaliteta diljem istočnog Mediterana od 2. tisućljeća pr. Kr. do uspona Islama u 7. st. O povijesti zbirke piše J. Michael Padgett, kustos Princeton University Art Museum. Zbirka stakla se u Princetonu formira u kasnom 19. st. Od tada se obogaćuje otkupima, donacijama, istraživanjima, ostavštinama. Zbirku čine raznoliki grčki, rimski, bizantski i ranosrednjovjekovni stakleni predmeti uglavnom istočnomediteranskog podrijetla; podrijetlo predmeta je u početcima, a u skladu s duhom vremena, rijetko bilježeno, pa se pretpostavlja da su neki predmeti nađeni u istraživanjima dok su neki kupljeni na tržnicama Damaska, Kaira i Bejruta.

Anastassios Antonaras, autor, u lijepoj se uvodnoj zahvali, iz koje doznajemo o okolnostima nastanka

This hard-cover large-format book (292 x 248 x 43mm), divot-publication, published in January 2013 on 408 pages, almost all finds dated to ancient times from the collection of the Princeton University Art Museum are presented - 509 of them, mostly vessels, but also other glass artifacts. They were collected for over one hundred years from sites all over the Eastern Mediterranean and are dated to times from the 2nd millennium to the rise of Islam in the 7th century. The history of the collection is discussed by J. Michael Padgett, curator at the Princeton University Art Museum. The glass collection of Princeton was formed in the late 19th century. Since then it has been enlarged through acquisitions, donations, research and inheritance. The collection includes different Greek, Roman, Byzantine and early Medieval glass objects mostly from the eastern Mediterranean; at the beginning, the origin of the finds was, in accordance with the spirit of those times, rarely noted, and it is supposed that some objects were found in excavations and that some were bought on markets in Damascus, Cairo and Beirut.

ove knjige, potpisuje kao arheolog i muzeolog. Antonaras je kustos Muzeja bizantske kulture u Solunu. Aktivan je u *Association Internationale pour l'Histoire du Verre* (AIHV), osobito u organizaciji uspješnog 18. međunarodnog kongresa navedene udruge u Solunu 2009. god., kada nas je počastio knjigom *Roman and Early Christian Glassworking. 1st c. B.C. – 6th c. A.D. Production and Products. Vessels from Thessaloniki and its environs*, (Athens 2009.), a od 2012. i kao glavni tajnik Udruge.

U ogledu *Povijest antičkog stakla* autor Anastassios Antonaras sažima povijest grčkog, rimskog i bizantskog stakla. Građa je potom prikladno katalogizirana prema tehnikama proizvodnje, a svaki kataloški broj je dataljno opisan i ilustriran kolor fotografijom, odnosno crtežom.



Povijest antičkog stakla je nevelik ali esencijalan, bogato potkrijepljen tekst.

U *Uvodu u antičko staklarstvo* na prvom su mjestu *Staklari*. Autor iz oskudnih povijesnih, literarnih i usporednih izvora za slične profesije izvlači obrise gospodarskog i socijalnog statusa staklara. Oni su, kao i drugi rimski obrtnici, pripadali najnižoj društvenoj ljestvici, to obzirom na aristokratsko poimanje rada rukama kao ropskog. Ipak su četvrti nekih gradova gdje su bile locirane njihove radionice sukladno njihovoj uspješnoj aktivnosti nazivane sta-

Anastassios Antonaras, the author, defines himself as an archaeologist and museologist in the nicely-written introduction of the book, where he also describes the circumstance in which the book was written. Antonaras is a curator at the Museum of Byzantine Culture in Thessaloniki. He is an active member of the *Association Internationale pour l'Histoire du Verre* (AIHV), especially active in the organization of the successful 18th international congress of said association held in Thessaloniki in 2009 where he presented his book entitled *Roman and Early Christian Glassworking. 1st c. B.C. – 6th c. A.D. Production and Products. Vessels from Thessaloniki and its environs*, (Athens 2009). Since 2012, he is also the head secretary of the Association.

In the overview entitled *A History of Ancient Glass*, the author, Anastassios Antonaras summarizes the history of Greek, Roman and Byzantine glass. The material is adequately catalogued based on production technique, and each catalogue number is described in detail and accompanied by a photograph, that is, a drawing.

A History of Ancient Glass is not a large, but is an essential, richly-supported text.

In the *Introduction to Ancient Glassmaking, Glassworkers* are in first place. The author, from scarce historical, literary and comparative sources for similar crafts, lists the economic and social status of glassworkers. They, like other Roman craftsmen, belonged to the lowest social ranks because of the fact that the aristocracy viewed manual labor as slave-related. However, some quarters of some cities where their workshops were located, were called glassworker's quarters to honor their success. The names of glassworkers and, occasionally, their origins, are known exclusively from epigraphic sources: tombstones or inscriptions from the vessels themselves. In the text, the author fluently summarizes all problems pertaining to inscriptions on vessels both in Greek and Latin, discusses vessel types, the reasons why and ways how the inscriptions were made, the names, origin, gender, and social status of the glassworkers and the workshop owners. Some glassworkers were freed slaves, others were free citizens and some, like Ennion in the east or Frontin in the west, might have been entrepreneurs. The author lists possible differences and similarities, and the reasons for them, in the organization of glass production between the

klarskima. Imena staklara i katkada mjesta njihova podrijetla poznata su isključivo iz epigrafskih izvora: nadgrobnih natpisa ili natpisa sa samog posuđa. Autor je u tekstu što glatko teče sažeo svu problematiku natpisa na samom posuđu na grčkom ili latinskom, o tipu posuđa, o razlozima i načinu utiskivanja natpisa, o imenima, o podrijetlu, o spolu, o statusu staklara, odnosno vlasnika radionice. Neki su staklari bili oslobođenici, drugi slobodni građani, neki su, kao Ennion na istoku ili Frontin na zapadu, pretpostavlja se, bili poduzetnici. Navodi moguće razlike i sličnosti, i njihove razloge, u organizaciji staklarske proizvodnje između zapadnih i istočnih provincija Rimskog Carstva. Podatke o dostupnosti stakla temeljene na usporednim cijenama stakla i keramike, te naknadama i troškovima staklara temelji na Dioklecijanovom Ediktu o najvišim cijenama - jedinom dokumentu u kojem se navode cijene stakla nakon, odnosno izuzev Strabonove napomene o maloj vrijednosti staklene čaše. Znanja o trgovini staklom, sirovinom i proizvodima, s ishodištem na istočnom Mediteranu, na velike udaljenosti, temelje se na arheološkim nalazima kao i na Dioklecijanovom Ediktu, iz čega je jasno da se kao jeftiniji i sigurniji preferirao maritimni transport od kopnenog. Staklo je u pravilu bilo samo manji dio tereta što se prevozio, tako da nekad nije jasno je li riječ o teretu ili privatnom vlasništvu člana posade ili putnika, a u svakom slučaju riječ je o komadima sirovine ili o luksuznom posuđu, rijetko o utilitarnom posuđu. Navode pisanih izvora o načinu pakiranja stakla omotanog slamom ili papirusom, transportiranog u slamnatim košarama, odnosno drvenim kutijama, potvrđuju etnografska istraživanja. Tijekom 1. st. staklom se trgovalo na velike udaljenosti iz raznih istočnih i zapadnih proizvodnih središta. Od 2. st. staklo se uglavnom proizvodi na licu mjesta tehnikom slobodnog puhanja, a importira iz obližnjih proizvodnih središta. Staklo se, sudeći prema nalazima u Delu, Cosi, Colchesteru, moguće i u Herkulaneu i Karanisu, po svoj prilici prodavalo u dućanima zajedno sa srodnim keramičkim proizvodima. Staklo se prodavalo u dućanima gdje se proizvodio i njihov sadržaj, te u okviru same radionice stakla, ako je bila na povoljnoj lokaciji. Ranije se staklo prodavalo na komade, a već od ranog 1. st., od kada je jeftino, u setovima, što potvrđuju arheološki nalazi i izvori. Slijedi odlomak *Sirovine* u kojem se navode sirovine za proizvodnju stakla - kvarc, soda i vapnenac, njihovi omjeri, izvori. Navode se sastojci dodavani u temeljnu smjesu i načini koloriranja, kao i dekoloriranja stakla inače prirodno zelenkaste nijanse. U odlomku *Proizvodnja* naglašava odvojenu proizvodnju samog stakla (glassmaking ili primarna proizvodnja) od sirovina i proizvodnju staklenih

western and the eastern provinces of the Roman Empire. He bases data on the availability of glass on comparative prices of glass and pottery and additional reimbursements and expenses issued in Diocletian's *Edict on Maximum Prices* – the only document which lists the prices of glass after, that is, if we exclude Strabo's note on the price of one small glass. Knowledge about glass trade, raw materials and products, originating on the eastern Mediterranean, and spreading over vast distances, is based on archaeological finds and Diocletian's *Edict*, which clearly states that preferred trade was by sea because it was cheaper and more reliable than trade by land. Glass was generally a small part of the transported cargo, so it is sometimes not clear if it was cargo or the private property of a crew member or some passenger, and was, in any case, either transported as raw material or luxury vessels, and rarely utilitarian vessels. Ethnographic research attests to what written sources say about the way glass was wrapped in hay or papyrus and transported in baskets or wooden boxes. During the 1st cent., glass trade was happening over vast distances from different eastern and western production centers. From the 2nd cent., glass was mostly produced on the spot by free-blowing and was imported from near-by production centers. Glass was, based from the finds from Del, Cosa, Colchester, possibly even Herculaneum and Caranis, most probably sold in stores along with similar ceramic products. Glass was sold in stores which produced its contents and within glass workshops themselves if they were in a suitable location. Earlier, glass was sold by individual pieces, and from the early 1st cent., when it became cheap, in sets - a fact attested to by archaeological finds and sources. The next paragraph is entitled *Raw Materials* and it lists the raw materials necessary for glass production – silica, soda and calcium, as well as their ratios and sources. There is also a list of ingredients added to the basic mixture and an explanation of coloring and de-coloring processes for glass which is naturally of greenish color. The part on *Production* emphasizes the separate production of glass itself (glassmaking or primary production) from raw materials, and the production of glass objects (glassworking or secondary production) from previously produced glass. Apart from the fact that glass and glass objects were made separately during the Antiquity and the Middle Ages, they were also made in different places at different times. Glass objects were made by *ίαλουργός/ίελουργός* in his workshop *ίαλουργεᵃον/ίελουργεᵃον*, that is, *vitrearius/vitriarius* in his workshop *vitrarium*. Ancient Greek terms *ίελοψός* and *κάμινος ίελοψική* refer to the glassmaker and his furnace. The Latin term *(re)*

predmeta (glassworking ili sekundarna proizvodnja) od prethodno proizvedenog stakla. Osim što su tijekom antike i srednjovjekovlja odvojeno proizvođeni, staklo i stakleni predmeti su se proizvodili u različitim područjima i vremenima. Staklene predmete je proizvodio *ίαλουργός/ίελουργός* u svojoj radionici *ίαλουργεᵃον/ίελουργεᵃον*, odnosno *vitrearius/ vitriarius* u svoj radionici *vitrarium*. Starogrčki se, pak, termini *ίελοψός* i *κάμινος ίελοψική* odnose na proizvođača stakla i njegovu peć. Latinski se termin *(re)coquere* izjednačava s grčkim *Çψειν* semantički pokrivajući koncept proizvodnje stakla, dok se riječ *vitrifactor* što odgovara grčkom *ίελοψός* javlja tek u 7. st.

U poglavlju *Primarna proizvodnja: izradba sirovog stakla* autor pomoću oskudnih nepokretnih arheoloških nalaza i izvora, te samog stakla i staklenih izrađevina registrira načine proizvodnje stakla u razdoblju od otkrića u Mezopotamiji do bolje dokumentiranog rimskog razdoblja. Navodi kako su u tekstovima klinastim pismom na mezopotamskim glinenim pločicama zabilježeni recepti za pravljenje stakla, te tri tipa staklarskih peći. Navodi artefakte s raznih azijskih i egipatskih nalazišta koji ukazuju na određeno izvorište sirovina, te ingote što ukazuju na oblik i materijal peći. Ingoti nađeni u brodolomima svjedoče da se primarna proizvodnja stakla do sredine 2. tisućljeća pr. Kr. odvijala na lokacijama udaljenima od onih na kojima se staklo oblikovalo u posuđe i druge izrađevine.

U rimsko doba samo se u nekoliko radionica proizvodilo staklo fuzijom sirovina, a te su radionice otkrivene uglavnom na istočnom Mediteranu. Fizikalno-kemijske analize su pokazale da se egipatsko staklo nije izvozilo, za razliku od sirijsko-palestinskog kojim se opskrbljavalo carsko tržište. Tijek primarne proizvodnje, od izgradnje velikih jednokratnih keramičkih peći u proljeće, skupljanja i sušenja drva u ljeto do proizvodnje stakla u jesen na postojanoj temperaturi od 1100°C, ilustrira nalazom iz Bet E'liezera u Izraelu datiranom u 6. – 7. st.

U poglavlju *Sekundarna proizvodnja: oblikovanje staklenih predmeta* prvo doznajemo o *Lokacijama radionica* koje su, barem u ranocarskom razdoblju, malene jedinice uglavnom smještene na periferiji grada zbog smanjenja rizika od požara. Bizantski zakonodavac propisao je u slučaju nužnog smještaja radionice unutar gradskih zidina obvezu smještanja iste u nenaseljenim, udaljenim područjima. Ipak su u kasnoantičko doba brojni primjerci radionica u napuštenim javnim prostorima, u građevinama u centru grada (Solun, Salona i dr.). Staklari su djelovali u blizini drugih obrtnika kojima je trebala peć za rad, a ponekad su dijelili peć s metalurzima i keramičarima. Radionice su djelovale i u blizini

coquere is equal to the Greek *Çψειν*, semantically covering the concept of glassmaking, and the word *vitrifactor*, matching the Greek *ίελοψός*, appeared in the 7th century.

In the chapter on *Primary Production: Making Raw Glass,* the author, with the help of scarce immovable archaeological finds and sources, as well as glass and glass artifacts, registers the ways in which glass was produced since its discovery in Mesopotamia to the better documented Roman times. He states that texts written in the cuneiform script on Mesopotamian clay tiles contain recipes for making glass and three types of glass furnaces. The author goes on to list various Asian and Egyptian sites which might have been the source of raw materials, as well as ingots which point to the form and material used for furnaces. Ingots found in shipwrecks attest to the fact that primary production of glass until the mid-2nd cent. was done on locations far from those where glass was formed into vessels and other artifacts.

In Roman times, only few workshops produced glass by fusing the ingredients, and these workshops were mostly found on the eastern Mediterranean. Physical and chemical analyses have shown that Egyptian glass was not exported, unlike the one from Syria and Palestine which supplied the entire Empire market. Primary production, from building large once-used furnaces in the spring, gathering and drying of timber in the summer, to the production of glass in the fall on a steady temperature of 1100°C, is illustrated by the find from Bet E'liezera in Israel, dated to the 6th and the 7th century.

In the chapter on *Secondary production: Forming Glass Objects,* the reader learns about *Locations of Glassworking Workshops* which were, et least in the early Empire, small units mostly placed on the periphery of cities to reduce the risk of fires. A Byzantine legislator proscribed that, if glass workshops had to be placed inside the city walls, they had to be placed in uninhabited distant locations. In the Late Antiquity, however, many workshops were placed inside abandoned public places and buildings in the city center (Thessaloniki, Salona etc.). Glassmakers worked close to other craftsmen who used furnaces in their work, and they sometimes shared their furnaces with smiths and pottery makers. Workshops were also open close to military camps, in towns and isolated agricultural communities. Apart from archaeological data about the locations of workshops within and outside city walls, about glassworkers' quarters, as well as about the recycling of glass and the like, can be on inscriptions and in literary sources. In the chapter entitled *The Workshop: Furnace, Fuel and Tools*, and

vojnih logora, u gradićima i izoliranim poljodjelskim zajednicama. Uz arheološke dokaze o smještaju radionica unutar i izvan zidina, o staklarskim kvartovima, o recikliranju stakla i sl. zna se iz natpisa i literarnih izvora. U odlomku *Radionica: peć, gorivo i oruđe*, a na temelju arheoloških dokaza i etnografskih poredbi opisuje jednostavne staklene peći za proizvodnju staklenih predmeta. Navedeno ilustrira prikazima na keramičkim lucernama iz Voghenze u Italiji, antičke Aserije u Hrvatskoj i Spodnje Škofije u Sloveniji datiranima u 1. st. i egipatskom figurom Erota s oruđem staklara datiranom u 1. ili 2. st. Kako je sažeto u naslovu odlomka za učinkovit rad radionice bila je potrebna mala, kratkotrajna peć, konstruirana od keramike, kamenja i žbuke, pravokutne ili kružne, odnosno potkovičaste strukture, s ugrađenim talioničkim tankom ili umetnutim keramičkim, rjeđe kamenim talioničkim loncem. Ložište je kao donji dio strukture najčešće bilo djelomično ukopano. Uz operabilni otvor, s vanjske strane peći ugrađena je uglavnom mramorna glatka površina za završno oblikovanje stakla. Osim od kupljene sirovine iz primarnih radionica do stakla se, od flavijevskog doba (69. – 96. g. po. Kr.) dolazilo i recikliranjem proizvoda sekundarnih radionica. Neposredno po oblikovanju stakleni predmet se morao hladiti od osamnaest do dvadeset sati kako ne bi pukao. Staklo se postupno hladilo u zato predviđenom malom prostoru uz samu peć. Konstruktivnim elementima (primjerice nisko nadsvođena mala peć, jedan operabilni otvor) se, između ostalog, štedjelo skupo gorivo, uglavnom suho i lagano drvo, osobito tamaris i papirus. Za takvom pećі je radio samo jedan staklar. Pa ipak je nađeno nekoliko radionica u kojima je istovremeno radilo više peći, kao ona u Gradištu kraj Gabrova u Bugarskoj. Budući se staklo stalno recikliralo malo je nađenih ostataka od proizvodnje staklenih predmeta. Tipični su ostatci i dokazi postojanja staklarske radionice: suzolike pokusne kapljice na podu radionice, kao i ulomci stakla s tragovima poda ili drugih površina s kojima su došli u kontakt dok su bili vrući, te polukružni prstenasti ulomci ostatka staklenog mjehura odlomljenog s puhaljke, a ponekad se po uklanjanju posude s puhaljke nakon hlađenja po formiranju oboda sačuva konični višak stakla, potom ulomci keramičkog talioničkog posuđa s prekrivenog unutrašnjim slojem vrućeg stakla, zatim ostatci ingota i hrpe staklenih ulomaka namijenjene recikliranju. Jedino oruđe koje se vezuje isključivo uz staklarstvo je željezna puhaljka, dugačka cijev za puhanje stakla. Ostalo se metalno oruđe vezuje i uz druge obrte. Na postojanje staklarske radionice ukazuju i nalazi kalupa.

U odlomku *O tehnikama oblikovanja stakla* opisuje

based on archaeological evidence and ethnological comparisons, the author describes simple glass furnaces for used for making glass objects. The listed facts are illustrated by depictions shown on pottery lamps from Voghenza in Italy, ancient Asseria in Croatia and Spodnja Škofija in Slovenia which can be dated to the 1st cent., and by an Egyptian figurine of Eros with glassworkers' tools which can be dated to the 1st or the 2nd century. As the title of the chapter summarizes, to be efficient, a workshop required a small dispensable furnace constructed from bricks, stones and plaster, and which had a rectangular or circular, that is, a horseshoe-shaped structure with an inbuilt smelting tank or an inserted ceramic, rarely stone, crucible. The firebox, as the lower part of the structure, was most often partially dug-in. Along with the operable opening, the outside of the furnace had an inbuilt, most often marble smooth surface used for marvering - the finishing processing of glass. Apart from bought raw material from primary workshops, glass was, from the Flavian era (69 - 96 AD) obtained through recycling the produce of secondary workshops. Right after the glass object was formed, it had to cool down for eighteen to twenty hours in order not to fracture. Glass was cooled gradually in a small space (annealing chamber) next to the furnace. The constructive elements (for example a small lowvault furnace and one operable opening or "glory hole") were used to safe on expensive fuel, mostly dry light wood, especially tamaris and papyrus. Such a furnace could only be used by one glassmaker. And yet, several workshops were found which used several furnaces simultaneously, like the one at Gradište near Gabrovo in Bulgaria. Seeing that glass was constantly being recycled, there are few remains from the process of glass production. Typical remains and evidence proving the existence of a glass workshop are: tear-shaped test drops on the workshop floor, as well as glass fragments with traces of floors or other surfaces they came in contact with when they were hot, and semi-circular ring-like fragments or moils cut off from the blowpipe, and sometimes, after the vessel is cracked off when the rim is formed, a final excess of glass is preserved, as are fragments of ceramic vessels used as crucibles which are covered with a layer of glass on the inside, remains of ingots and piles of glass fragments intended for recycling. The only tool exclusively linked to glassblowing is an iron blowpipe, a long hollow rod used to blow glass. Other metal tools can be connected to other crafts. Finds of mould also indicate the existence of a glassworkers' workshop.

In the part of the *Glass-Forming Techniques*, the author lists nine ways of forming glass objects. Ne

devet načina oblikovanja staklenih predmeta. Navodi moguće, ali rijetko rabljenu *tehniku rezbarenja*, uklanjanjem mase stakla s tijela posude svrdlom ili sličnim oruđem. *Tehnika (omatanja) štapa* se rabila za izradbu perli i narukvica u Egipu tijekom 2. pol. 2. tisućljeća pr. Kr. i na Bliskom Istoku između 6. i 4. st. pr. Kr., te za izradbu uskog posuđa u Helenizmu, a u 4. i 5. st. na sirijsko-palestinskom području. *Tehnikom jezgre* oblikovalo se posuđe pomoću dugog metalnog štapa s vrhom prekrivenim jezgrom od organskih i neorganskih materijala. Ističe se jedna od mogućnosti oblikovanja staklenog predmeta ovom tehnikom: zagrijana jezgra se prevlačila slojem smrvljenog stakla pomiješanog s malo vode, potom se u peći staklo fuziralo oblikujući posudu što se na kraju dekorirala omatanjem i povlačenjem niti kontrastnog stakla u peroliki uzorak. Ta se tehnika rabila u Mezopotamiji u 15. st. pr. Kr., potom u Egiptu u auličke svrhe što je pridonijelo kakvoći izradbe. Čini se da je došlo do prekida proizvodnje staklenog posuđa tehnikom jezgre između 10. i 8. st. pr. Kr. do njezinog ponovnog aktiviranja u Mezopotamiji. Na egejskom području od 6. st. pr. Kr. do 1. st. pr. Kr. tom se tehnikom imitira suvremeno grčko keramičko posuđe, uglavnom spremnici mirisnih i kozmetičkih supstancija. Tri su skupine posuđa dobivenog tom tehnikom grupirane, proizvođene i proširene na različitim dijelovima istočnog Mediterana i u Italiji.

Tehnikom lijevanja oblikovalo se stakleno posuđe u kalupu punjenom staklenim otpadom. Temelji se na tehnici izgubljenog voska tako da se stakleni otpatci sipaju u prazninu između dva dijela kalupa i zagrijavanjem fuziraju oblikujući posudu. *Zagrijavanje* je tehnika kojom su se proizvodili planokoveksni žetoni i geme i to zagrijavanjem komada stakla na ravnoj podlozi. *Tehnikom nalijeganja* oblikovalo se posuđe otvorenih oblika zagrijavanjem staklenog diska u pozitivnom ili šupljem, odnosno na negativnom ili konveksnom kalupu, pri čemu, zahvaljujući gravitaciji i prikladnom manipuliranju, staklo postupno naliježe zadobijajući oblik kalupa. Ta se tehnika obilno rabila prije izuma puhanja stakla. Tako se mozaičko posuđe izrađivalo od vrpci i/ili odsječaka staklenog štapića. Vrući stakleni štapići u određenim bojama povezali bi se obrađivanjem i prijanjanjem u debeli svežanj koji je sadržavao željeni uzorak. Svežanj se ponovo zagrijavao i razvlačio do dužine od nekoliko metara u štap malog promjera s uzorkom po cijeloj dužini. Štap se potom rezao, a njegovi diskoidni odsječci su oblikovali mozaičko posuđe, arhitektonske inkrustacije, odnosno umetke za namještaj. Odsječci su se zagrijavali na ravnoj površini do fuziranja u disk na koji se dodavala

mentions the possible but seldom used technique of *carving*, whereby a mass of glass is removed from the body of the vessel with an bow drill or a similar tool. The *winding-rod forming* was used to make beads and necklaces in Egypt during the second half of the 2nd millennium. BC and in the Middle East between the 6th and the 4th cent. BC, as well as to make narrow vessels during Hellenism and in the 4th and 5th centuries in Syria and Palestine. The *core forming* was used to form vessels with the help of a long metal rod which had a tip covered with a core of organic and inorganic material. The author mentions one possible way to form a glass vessel using this technique: the heated core was covered with a layer of crushed glass and some water, and the furnace was then used to fuse the glass and form the vessel which was later decorated by wrapping and sliding contrasted glass to make a feather-like motif. This technique was used in Mesopotamia in the 15th cent. BC, then in Egypt for highborn families, which helped improve the quality. It seems that the core technique was not used between the 10th and the 8th cent. BC, until it was rediscovered in Mesopotamia. On the Aegean territory, this technique was used from the 6th to the 1st cent. BC to imitate contemporary Greek ceramic vessels, mostly containers for fragrant and cosmetic substances. Three groups of vessels made by applying this technique were grouped, produced and spread to different parts of the eastern Mediterranean and Italy.

Casting was used to form glass vessels in a mould filled with cullet. It is based on the technique of lost-wax so that the glass cullet are poured into a cavity between two parts of a mould and are then heated and fuse to form a vessel. *Firing* is a technique used to make plano-convex game counters and gems by heating a chunk of glass on a flat surface. *Slumping* was used to form open-shaped vessels by heating a glass disk in a positive or hollow, that is, on a negative or convex mould, thereby making the glass fall downwards and take the form of the mould due to gravity and appropriate handling. This technique was frequently applied before glassblowing was invented. Mosaic vessels were made from ribbons and/or horizontal bars or cane sections of glass. Molten glass canes on certain colors would be connected by processing and adhering into a tight bundle which formed the desired motif. The bundle was then reheated and pulled out until it turned into a several meter long thin rod which had the motif all the way through. The rod was then cut and its discoid cutoffs were formed into mosaic vessels, architectural incrustations, that is, into furniture inlays. The cutoffs were heated on a flat surface until

obodna vrpca od namotanih niti najčešće bijelog i modrog stakla. Takav disk je tehnikom nalijeganja na konveksni kalup postajao posuda. Moguće je za neke tipove posuđa rabljen dvodijelni kalup punjen oblim teserama, odsječcima cilindričnih štapova, zatvoren i zagrijavan do fuziranja tesera. Po hlađenju unutrašnja strana posude bi se glačala pomoću tokarilice. *Millefiori* mozaičko posuđe tako je nazvano zbog odsječaka kompozitnih mozaičkih štapova u obliku cvijeta. *Reticelli* posuđe oblikovano je zagrijavanjem fuziranih štapića u disk odnosno namatanjem štapa na kalup uz pomoć drvene lopatice; a štap koji se namatao na kalup ili od kojeg su odsječci, štapići formirani u disk izrađivao se rotacijom spiralno izvučenih niti bojenog stakla prethodno apliciranih na bezbojno rastaljeno staklo. Mramorasto mozaičko staklo kojim se imitiralo poludrago kamenje oblikovano je na sličan način, spiralnim namatanjem kompozitnog štapa na ravnu površinu, uz pritiskanje u jednakim intervalima kako bi se spiralni motiv valovito iskrivio da bi se nalijeganjem na kalup dekorativni uzorak dodatno zamrsio. I neki su zatvoreni oblici, unguentariji, oblikovani zagrijavanjem diska sastavljenog od staklenih odsječaka. Disk je zagrijavanjem nalijegao na ovalni gipsani kalup, gravitacijom je oblikovan njegov donji, konični dio, a ulegnuti ostatak je uz pomoć drvene lopatice preoblikovan u uski cilindrični vrat. Na kraju se kalup razbio a njegovi ostatci su se uklanjali iz unutrašnjosti posude. Kod zlatovrpčastog mozaičkog posuđa zatvorenih oblika vrpca složena od zlatnog listića između dva lista od prozirnog stakla zagrijavala se, fuzirala do oblikovanja u disk i nalijeganja na kalup zajedno s drugim kompozitnim vrpcama od neprozirnog stakla od dvije ili tri različite boje.

Utiskivanjem u kalup oblikovao se predmet utiskivanjem viskoznog stakla u otvoreni keramički ili gipsani kalup s dekorativnim uzorkom u negativu. Tom se tehnikom oblikovalo rešetkasto posuđe, odnosno posuđe s visokim reljefom.

Utiskivanjem rotiranjem oblikovao se predmet utiskivanjem viskoznog stakla uz pomoć klipa u otvoreni keramički ili gipsani kalup koji se rotirao na lončarskom kolu čime se postizala simetrija. Kalup bi se potom razbio. Moguće je barem djelomice tom tehnikom izrađivano kameja stakleno posuđe. Varijantom te tehnike proizvodile su se rebraste zdjele tako da se zagrijani disk stavljao na kružni kalup kako bi se oblikovala posuda uz istodobno radijalno utiskivanje šipkom kako bi se formirala rebra. Zdjela se stavljala u peć gdje je izložena vrućini što je glačala njenu vanjsku površinu. Unutrašnjost i vanjski obodni dio je poliran na hladno što je ostavljalo tragove finih strija. Dodajmo da se vjerojatno Plinijev

they fused into a disk which was then covered with a rim ribbon of wound threads of, most commonly, white and blue glass. Such a disk was then processed by the slumping technique to form a vessel. It is possible that some types of vessels were made using two-part moulds filled with round tesserae cut from cylindrical canes which were then closed and heated until the tesserae fused. When the vessel cooled down, the inner surface would be polished using a lathe. *Millefiori* mosaic vessels got their name because of the cutoffs from composite fused sticks which were formed like flowers. *Reticelli* vessels were formed by heating fused canes into a disk, that is, by winding the cane over a mould using a wooden spatula (paddle); the cane which was wrapped over the mould or which yielded the cutoffs which were formed into a disk was made by twisting threads of colored glass onto or inside colorless molten glass. Marbled mosaic glass which imitated semiprecious stones was formed in a similar way, by spiral winding of the composite cane onto a flat surface with applying pressure at regular intervals to in order to deform the spiral motif in a wave so that the disk could additionally smudged when it slump into the mould. Some closed forms, unuguentaria, were formed by firing a disk made up of glass cutoffs. When heated, the disk would slump onto an oval plaster mould, gravity formed its bottom, conical part, and the slumped remainder was formed into a narrow cylindrical neck with a paddle. Finally, the mould would be broken and its remains were removed from the inside of the vessel. Gold bands were inserted into closed-form vessels; a band made up of a sheet of gold leaf incased between two sheets of transparent glass was heated and fused until it was formed into a disk and slumped over a mould along with other composite bands made out of non-transparent glass in two or three different colors.

Mould pressing was used to form an object by pressing viscous glass into an open ceramic or plaster mould with a decorative motif in the negative. This technique was used to form cage cup vessels or those with high relief.

Rotary pressing was used to form objects by pressing viscous glass with the help of a plunger into an open ceramic or plaster mould which was rotated on a pottery wheel to achieve symmetry. The mould would then be broken. It is possible that this technique was at least partially applied to make cameo glass vessels. A variant of this technique was used to make ribbed bowls by placing a heated disk onto a round mould in order to form the vessel and simultaneously press it radially with a rod to create the ribs. The bowl was placed into a furnace

izraz *torno terere* odnosi na obradu stakla na lončarskom kolu. Tijekom julijevsko-klaudijevskog doba varijantom utiskivanja rotiranjem se proizvodilo posuđe što imitira suvremene keramičke i srebrene oblike. Jednostavna tehnika se koristila za dobivanje posuđa pod utjecajem keramičke proizvodnje. Zagrijana staklena masa bi se stavila na lončarsko kolo a klipom se i lopaticom, kao nadomjestcima za lončareve ruke, oblikovalo dno i stijenka.

Slobodno puhanje podrazumijeva napuhivanje i oblikovanje vrućeg stakla uporabom daha kroz toplinski izoliranu puhaljku. Prema Pliniju puhanje stakla, odnosno *flatu figurare* ili oblikovanje dahom je jedna od tri tehnike koje su Sidon učinile glasovitim staklarskim središtem. Nalazi u jeruzalemskoj staklarskoj radionici upućuju da je ta osobina stakla poznata od 1. pol. 1. st. pr. Kr. na sirijsko-palestinskom području s vjekovnom staklarskom tradicijom. Tehnika se usavršila tijekom stoljeća tako da je oko sredine 1. st. proširena diljem Rimskog Carstva, s radionicama na sirijsko-palestinskom području, u Italiji, Švicarskoj i Dalmaciji. Širenje i popularizacija tehnike poklapaju se s Augustovim dobom političkog mira i ekonomskog rasta što je u Italiju privlačilo trgovce i obrtnike, osobito one iz istočnih provincija, a zrcali se u količini i kakvoći staklenog posuđa sačuvanog na zapadu. Čini se da je puhanje stakla usavršeno u - Italiji, osobito u Rimu gdje su se iz financijskih razloga preselili staklari s istoka, osobito iz Sidona. Razvoju i usavršavanju tehnike puhanja doprinijele su promijene u konstrukciji peći, te šuplje cijevi za puhanje stakla – puhaljke. Rastaljeno staklo koje se zahvatilo donjim krajem puhaljke napuhalo bi se dahom u mjehur što se oblikovao u tijelo i vrat posude. Najkasnije do treće četvrtine 1. st. razvila se zatvorena nadsvođena peć u kojoj je bilo moguće rastopiti staklo u keramičkom talioničkom loncu i zagrijavati predmet koji se oblikovao izvan peći do postizanja željenog rezultata, za razliku od prethodnog oblikovanja predmeta nad otvorenom vatrom. Do oko sedamdesete godine po. Kr. puhaljke su evoluirale od prvobitnih staklenih, preko jednostavnih i jeftinijih keramičkih do željeznih puhaljki pomoću kojih je staklar mogao manipulirati s većim komadima rastaljenog stakla i tako proizvesti veće posuđe za transport i skladištenje tipično za kraj 1. st. Osim toga do tada se kao rekvizit u postupku puhanja počela koristiti još jedna puhaljka ili štap od punog željeza (držač) na koji bi se dopola dovršena posuda prebacila, uz pomoć komadića rastaljenog stakla na vrhu držača, što je ostavljalo traga na dnu posude, kako bi se mogao oblikovati njezin obod dok je još bila vruća, za razliku od prethodnog odlamanja, ili glačanja

where it was exposed to heat which helped polish its outer surface. The inside and the upper part were polished when the bowl was cold, which left traces resembling slight stretch marks. We would like to add that Pliny's expression *torno terere* probably refers to working glass on a pottery wheel. During the Julio-Claudian era, a variant of rotary pressing was used to make vessels which imitated contemporary pottery and silver forms. This simple technique was used to make vessels under the influence of pottery production. Heated glass mass would be placed on a pottery wheel and a plunger and a paddle were used instead of hands to shape the bottom and walls of the vessels.

Free-blowing includes inflation and forming molten glass by using human breath through a heat-insulated blowpipe. According to Pliny, glassblowing, that is, *flatu figurare* or shaping by breath is one of the three techniques which made Sidon a famoust glassworking center. Finds from a workshop in Jerusalem suggest that people knew about this specific characteristic of glass since the 1st half of the 1st cent. BC, in the Syro-Palestinian area - an area with an age-long tradition of glassworking. The technique was perfected over the centuries, and spread all over the Roman Empire in the 1st cent., including workshops in Syro-Palestinian area, Italy, Switzerland and Dalmatia. The spread and popularization of this technique coincide with Augustus' time of political peace and economic growth which attracted merchants and craftsmen to Italy, especially those from the eastern provinces which was, in turn, mirrored in the quantity and quality of glassware preserved in the west. It seems that glassblowing was perfected in Italy, especially Rome where merchants from the east, mostly Sidon, migrated due to financial trouble. The development and perfecting of the technique was also aided by changes in furnace construction and hollow rods for glassblowing - blowpipes. Molten glass was scooped up with the lower end of the blowpipe and would be blown into the parison which was then formed into the body and neck of the vessel. A closed vaulted furnace was developed by the third quarter of the 1st cent. which could be used to melt glass in a clay crucible and to heat up the object which was formed outside the furnace until the desired affect was obtained, unlike before when the object was formed over an open fire. Until about 70 AD, blowpipes evolved from the first glass, to simpler and cheaper ceramic and iron ones which could be used by the glassblower to manipulate larger pieces of chunks of molten glass thereby producing larger vessels used for transport and storage typical of the late 1st century. Apart from that, a second blowpipe

nakon što se posuda ohladila. Na držaču su se, osim toga, aplicirali i funkcionalni (ručice) i dekorativni elementi.

Puhanje stakla ubrzalo je, uvećalo, proširilo i pojeftinilo proizvodnju stakla tako da je, a tomu svjedoči Strabon koji piše na prijelazu 1. st. pr. Kr. u 1. st., posuda koštala jedan bakrenjak. I tako jeftino staklено posuđe je bilo desetak puta skuplje od srodnog keramičkog. Počelo se prodavati po težini, a novost je i korištenje staklenog posuđa za transport i skladištenje drugih proizvoda.

U odlomku *O dekorativnim tehnikama i motivima* opisuje devet načina dekoriraranja staklenog posuđa i njihovim specifičnostima. *Puhanje stakla u kalup* podrazumijeva puhanje zagrijanog staklenog mjehura u kalup s dekoracijom u negativu. Tom tehnikom je proizvedeno relativno malo posuđa čak i u vrijeme najveće popularnosti te tehnike, u 1. st. Glineni, kameni, gipsani, metalni kalupi su morali biti kvalitetni kako bi izdržali vrućinu i pritisak stakla Budući se staklo, za razliku od keramike, ne stisne nakon hlađenja, rabili su se dvodijelni ili višedijelni kalupi kako bi se posuda izvadila neoštećena. Puhanje stakla u kalup ili *argenti modo celare* prema Pliniju je jedna od tri tehnike po kojima je Sidon bio glasovito staklarsko središte, moguće je izumljena na sirijsko-palestinskom području iz želje da se staklenim posuđe imitira metalno. Komercijalno puhanje stakla u kalup počelo je u Augustovo doba, a njegov razvitak na zapadu, u vidu izrade stolnog posuđa od oko sredine 1. st. U modi je do kraja flavijevskog doba kada ga istiskuje fasetirano staklo. Na istoku, gdje nije bilo masovno proizvođeno, proizvodilo se još i u 2. st. Općenito uzevši kefalomorfno stakleno posuđe puhano u kalup proizvodilo se i u 4. st. Poligonalne staklenke za svetu vodu i ulje iz Svete Zemlje, s kršćanskim i židovskim religioznim motivima izrađuju se na istočnom Mediteranu kraja 6. i ranog 7. st. Uz posuđe u cijelosti oblikovano u kalup, s obodom ili ručicama koje staklar slobodno oblikovao, sačuvan je znatan broj posuda oblikovanih slobodnim puhanjem nakon prvotnog oblikovanja dekoracije u kalupu s dekoracijom proširenom na veću površinu posude i manje izbočenom. Takvo puhanje uzorka u kalup rabljeno je u više navrata tijekom rimskog doba, osobito u kasnocarsko doba. U nekim slučajevima rabljeno je kao početni stadij urezivanja.

Posuđe obrađenorezanje, *urezivanje kotačićem i graviranje*, dakle uklanjanjem dijela staklene mase uz pomoć lučne bušilice poznato je od klasičnog grčkog i helenističkog doba, a puni razvoj doseglo je u rimsko doba, izvorno je nazvano *toreumata* ili reljefno posuđe. Gravirani dekorativni uzorak oblikovan je na rotirajućoj tokarilici uz uporabu or solid iron rod (pontil, pounty) was introduced. A half-finished vessel would be put over this tool with the help of a small chunk of molten glass on tip of a blowpipe or rod, which left traces on the bottom of the vessel, so that the rim could be formed while the vessel was still hot, unlike before when the rim was cracked off or polishing after the vessel cooled down. The pontil was also used to apply functional (handles) and decorative elements.

Glassblowing made glass production bigger, wider and cheaper so that, as recorded by Strabo on the transition from the 1st cent. BC to the 1st cent. AD, the price of a vessel was one copper. Even such cheap vessels were about ten times more expensive than similar pottery vessels. Glass was being sold based on weight, and a novelty was introduced when glass ware started to be used for transport and storing of other produce.

In the part on *The Decorative Techniques and Motifs*, the author describes nine ways of decorating glass vessels and their specific features. *Mold blowing* includes blowing a heated glass bubble into a mould which has a motif in the negative. This technique was used to produce a relatively small number of vessels even at the time when the technique was very popular, in the 1st century. Clay, stone, plaster and metal mould had to be of high-quality making to stand the heat and the pressure of the glass. Seeing as glass, unlike pottery, does not shrink after cooling, twvo- or multi-part moulds were used so that the vessel could be taken out without being damaged. Blowing glass into a mould, or *argenti modo celare* is, based on Pliny, one of the three techniques which made Sidon a respected glass center, and it is possible that it was invented on the Syro-Palestinian territory from the desire to imitate metal vessels in glass. Commercial mold blowing spread in Augustan times and it developed in the west, in the sense of making table ware, around the middle of the 1st century. It stayed fashionable until the end of Flavian era when it was replaced by faceted glass. In the east, where there was no mass production, it was made in the 2nd cent. as well. Generally, head-shaped vessels ware was blown into a mould in the 4th cent. as well. Polygonal *eulogía* vessels for holding holy water and oil from the Holy land, with Christian and Jewish religious motifs, were made on the eastern Mediterranean at the end of the 6th and the early 7th century. Along with vessels entirely formed in a mould with a rim or handles which were shaped by the glassworker, a significant number of vessels were formed by additional free-blowing after the primary forming in a mould with larger and less pronounced decorations was also found. This, so called, dip-mold blowing, was used

zašiljenog metalnog oruđa, dakle tehnikom primijenjivanoj na minijaturama, osobito u proizvodnji i dekoriranju srebrenih i koštanih predmeta, odnosno posuđa. Prvo su se urezivali geometrijski motivi. Od 3. četvrtine 1. st. do pred kraj 1. četvrtine 2. st. bilo je u modi fasetiranje dekoloriranog staklenog posuđa debelih stijenki redovima ovala ili rižolikog uresa. Tijekom 2. i 3. st. tako se dekoriralo jeftinije, tanje stakleno posuđe, uglavnom hemisferične zdjele, a ukrasna poovršina posude je smanjena, svedena na pojaseve na određenim dijelovima posude.

Horizontalno žlijebljenje unutrašnje ili vanjske stijenke posude poznato od helenističkog doba u primjeni je tijekom cijelog rimskog doba.

Tijekom 3. i 4. st. posuđe je dekorirano tankim, plitkim, horizontalnim urezima grupiranim u pojaseve, ponekad u kombinaciji s većim pojasevima ili drugim geometrijskim uzorcima, kao što je popularni mrežasti romboidni motiv kojim je moguće prikazana zaštitna slamnata obloga posude.

Graviranje je rabljeno i u kombinaciji s tehnikom utiskivanja u rotirajući kalup u oblikovanju bogato urešenog posuđa. Tijekom 1. st. tako su se korigirale sitne nepravilnosti i dovršavala dekoracija posuđa u visokom reljefu. Tijekom 4. st. tako se dovršavala dekoracija *diatreta* ili rešetkastih čaša, ovo uz napomenu da je drugi, transparentni sloj stakla što je oblikovao tijelo i obod, utisnut u manji, perforirani kalup postavljen preko prvog sloja tamnog stakla. Drugi sloj je penetrirao kroz perforacije u kalupu usidrivši se u prvi sloj tankim potpornjima. Nakon uklanjanja oba kalupa staklar je među potpornjima rezao i brusio kreirajući čipkasti vanjski sloj nasuprot glatkoj pozadini tijela.

Staklari su od kraja 2., uglavnom tijekom 3. i 4. st. imali na raspolaganju oruđe, kotačiće različite debljine s kosim ili ravnim rubom te zašiljeno oruđe za ručno graviranje, kojim su, na temelju priručnika uzoraka, mogli kreirati figuralne motive mitološke i religiozne tematike, te one iz svakodnevice, primjerice lova.

Tehnika izradbe *kameja staklenog posuđa* također se vezuje uz graviranje. Tradicionalno mišljenje o višekratnom puhanju ili tzv. lijevanju višeslojnog posuđa što se poput kameja na hladno graviralo i poliralo, danas se napušta u korist uvjerljivijeg da je dekoracija na posuđu nastajala u trenutku oblikovanja posude utiskivanjem u rotirajući kalup u kojem je reljef u negativu ispunjen zdrobljenim vlažnim staklom jedne boje koje se topilo i fuziralo u kontaktu s utisnutim poluviskoznim staklom tijela posude druge boje. Malo je takvog posuđa koje je uglavnom datirano u kraj 1. st. pr. Kr. i u 1. pol. 1. in several periods in Roman times, especially in the late Empire. In some cases, it was used as the initial phase of cutting.

Vessels decorated by *wheel cutting and engraving*, that is, by removing a part of the glass mass with the help of an bow drill, were known since classical Greek and Hellenistic times, and were fully developed in Roman times. Originally it was called *toreumata* or relief ware. Engraved decorative patterns were formed with a sharpened metal tool on a rotating lathe, that is, by using the technique applied by miniature art, especially in producing and decorating silver and bone objects and ware. At first, geometrical motifs were engraved. From the 3rd quarter of the 1st cent. almost until the end of the 1st quarter of the 4th cent., it was fashionable to facet decolorized glass ware with thick walls with lines of oval or rice-graine shaped decorations. During the 2nd and 3rd centuries, this technique was used to decorate cheaper thinner ware, mostly hemispherical bowls, and the decorations were reduced and appeared in belts on certain parts of vessels.

Horizontal grooves of the inner or outer surface of a vessel were common decorative element throughout Hellenistic and Roman times.

In the 3rd and 4th centuries, vessels were decorated with clusters of thin, shallow horizontal engravings grouped in bands, sometimes in combination with larger bands or other geometrical patterns, like the popular rhomboid network motif, possibly depicting a hay encasement (strow cover) around a vessel.

Engraving was used in combination with mold pressing to make richly decorated ware. This helped correct small irregularities and finish vessels decorated with high relief in the 1st century. In the 4th cent., this was used to finish up the decorations on a *diatreta* or cage cups with the note that the second, transparent layer of glass which formed the body and the rim, pressed into a smaller, perforated mold placed over the first layer of dark glass. The other layer passed through the perforations in the mold and anchored itself in the first layer with thin struts. After both molds were removed, the glassmaker cut and abraded between the struts creating a lace-like outer layer opposite the smooth surface of the body.

From the end of the 2nd and throughout the 3rd and 4th centuries, glassmakers could use tools, wheels of different thickness with slanted or flat cut edge and pointed tools for engraving by hand which they used to, based on pattern handbooks, create figural mythological and religious, as well as motifs from everyday life, for example, hunting.

The technique of making *cameo glass ware* also included engraving. The traditional idea of multiple

st. Jednostavna zaravnjena dekoracija vertikalnih rubova dvoslojnog kameja stakla iz 4. st. u cijelosti je izvedena rezanjem.

Apliciranje staklenih niti najstariji je oblik dekoriranja *apliciranjem plastičnih elemenata* korišen u faraonskom Egiptu, u klasičnoj i helenističkoj Grčkoj, te u rimsko doba. Niti su mogle biti nanesene i utisnute u površinu prije finalnog oblikovanja tijela posude, kao kod primjeraka izrađenih tehnikom štapa i jezgre, odnosno nalijeganja na kalup – mramorastog mozaičkog stakla, ili puhanih rebrastih čaša tzv. Zarte Rippenschalen iz 1. st. Češće je nit stakla druge boje, uglavnom bijelog, nanošena nakon finalnog oblikovanja tijela posude od tamnog, uglavnom modrog stakla, pa je stoga reljefna. Dekoriranje apliciranjem reljefnih niti raširenije je između 2. i 4. st., kada su niti uglavnom istovjetne boje staklu tijela, aplicirane na cijelu posudu ili samo na njezine dijelove. U 2. i 3. st. raširenо je posuđe s apliciranim debelim zaravnjenim nitima u zmijolikom ili pticolikom uzorku s reljefnim motivom reptilske krljušti. Tijekom 4. i 5. st. deblje i šire zaravnjene ili svijene niti aplicirale su se uglavnom na tzv. Kohl cjevaste unguentarije. Osim niti na posuđe se od 1. st. valjanjem na vruće apliciralo jednostavne ulomčiće raznobojnog stakla, u početku reljefnog, potom inkorporiranog opetovanim puhanjam i valjanjem. U kasnoj antici ponovo je u modi apliciranje kružnih ulomaka. U 1. i opet u 4. st. u modi je posuđe s apliciranim medaljonima s prikazom Meduze, Bakha, teatarskih maski i lavljih glava, uglavnom u visokom reljefu. Na vrčevima su medaljoni aplicirani na spoju ručices tijelom, a poznati su i primjerci aplicirani duž cijelog opsega otvorene posude. Tijekom 3. i u 1. pol. 4. st. na posuđe su se aplicirani realistični zoomorfni uresi, odnosno uresi u obliku malog posuđa.

Pozlaćena stakla ili fondi d'oro u klasično doba korištena su kao dekorativni umetci za namještaj i kipove, a u helenističko doba kao dekoracija posuđa. Ponovno se javljaju u 4. st. Ne zna se kojim su tipovima posuđa pripadali jer nijedna čitava posuda nije sačuvana. Nađena su ravna dna umetnuta u gips kojim se zatvaralo grobove u rimskim katakombama. Dekorirana su motivima kršćanske, židovske i poganske tematike. Između ostalog pretpostavlja se da je riječ o darovanim uspomenama za formalnih prigoda, kao što su vjenčanja i obljetnice preuzimanja javnih dužnosti. Nije do kraja razjašnjena tehnika kojom se umetao zlatni listić na unutrašnje dno posude otvorenog oblika. Željeni bi se prizor ugravirao na zlato, a ponekad bi se detalji naglasili bojom. Potom bi se napuhao drugi mjehur stakla unutar ponovo

blowing or the, so called, casting of multilayer vessels which was then engraved when cold like cameos, is abandoned in favor of the more plausible idea that the decorations were made when the vessel was being formed by rotary pressing into a mold which had a negative relief filled with crushed moist glass of one color which then fused in contact with the semi-viscous body of a differently colored vessel. These vessels are rare and are mostly dated to the end of the 1st cent. BC and the first half of the 1st century. The simple flattened decoration with vertical edges on two-layer cameo glases of the 4th cent. was done entirely by wheel cutting.

Applying glass threads is the oldest way of decorating by *applying of plastic elements.* It was used in pharaoh Egypt, Classic and Hellenistic Greece and in Roman times. The threads could have been applied and marvered into the surface before the final forming of the body, like on finds made by the technique of the rod or core, or slumping - marbled mosaic glass or blown ribbed glasses, the so called Zarte Rippenschalen of the 1st century. Usually the thread of different color, mostly white, was applied after the final forming of the body from dark, mostly blue glass, so it is in relief. Decorating by applying relief threads was widely spread between the 2nd and the 4th cent. when threads, the same color as the vessel, were applied to the entire vessel or its parts. In the 2nd and 3rd centuries, vessels were decorated by snake thredaing, that is with thick flattened applied threads in a serpentine- or bird-like pattern with a relief motif of lizard scales. During the 4th and 5th centuries, thicker and wider threads were applied mostly to kohl-tube unuguentaria. Apart from threads, from the 1st cent., vessels were decorated by applying simple chip elements, at first relief and later incorporated by repeated blowing and marvering. In Late Antiquity, applying circular fragments became fashionable again. In the 1st and again in the 4th cent., vessels had medallions showing Medusa, Bacchus, theater masks and lion heads, mostly in high relief. Jugs had medallions applied to the transition between the handle and the body, and some had medallions all around the open vessel. During the 3rd and in the 4th cent., vessels had applied realistic zoomorphic decorations, and decorations shaped like small vessels.

Gold-glass or fondi d'oro were used in classical times as decorative inlays on furniture and statues, and in Hellenistic times as decorations on vessels. They reappeared in the 4th century. It is unclear to which type of vessel they belonged because none of them were completely preserved. There are flat bottoms embedded into plaster which was used to seal Roman catacombs. They have Christian, Jewish and

zagrijane posude. Novi stakleni sloj se vezao uz stijenke posude zaštićujući tako zlatnu dekoraciju među slojevima prozirnog stakla. U 6. st. ta se tehnika primijenjivala u izradbi tesera, obloga, pločica, zidnih oplata.

Stakleno posuđe s *udubljenjima* oblikovanima potiskom uz pomoć staklarskih kliješta na vrućoj posudi vjerojatno je, kao i keramičko, imitiralo vrjednije metalne prototipove. Ta je tehnika dekoriranja slobodno puhanog posuđa, poznata od 2. pol. 1. st., u najširoj uporabi od 2. do 4. st.

Štipanjem pomoću kliješta stvarala su se površinska izbočenja, tzv. peraje, na tijelu posude ponekad u funkciji njezina dna. Ta je tehnika karakteristična za istočni Mediteran kraja 2. st., u široj je uporabi od 5. pa, barem u Jordanu i na sirijsko-palestinskom području, do 8. st. Slično posuđe s debljim i pravilnije oblikovanim i aranžiranim perajama vjerojatno je oblikovano puhanjem u kalup tijekom 3. i 4. st. Također sličan ali složeniji dekorativni uzorak vertikalnih rebara ili rombova, zvan dvokraki ili *fadendekor*, proizvodio se štipanjem kliještima od vrata do dna posude prije finalnog oblikovanja njezina tijela.

Dvobojna dekoracija poznata od faraonskog Egipta, preko klasične Grčke, u rimsko i srednjovjekovno doba postizala se uporabom dviju ili više boja stakla u izradbi posude. Uglavnom su ručice, dno i aplicirana plastična dekoracija oblikovani od stakla živih boja različitog od boje tijela.

Slikana dekoracija, poput pozlate, rijetko je korištena tehnika u kasnoklasičnoj Grčkoj i helenizmu. Posuđe s bogatim oslicima javlja se u većem broju u 4. četvrtini 1. st. Oslik bi se, od svojevrsnog emajla od stakla u prahu željene nijanse pomiješan s vodom, zagrijavanjem fuzirao sa staklenom površinom.

Primjerci pozlaćenog posuđa i pločica iz 1. i 2. st. oslikavani su nakon postupnog hlađenja posude nanošenjem zlatnog listića na površinu potom dekoriranu graviranjem. Na hladno su se oslikavali i poklopci posuđa u 3. i 4. st. i to, zbog zaštite, obrnuto, s unutrašnje strane poklopca. Sve navedene tehnike korištene su i tijekom 3. i 4. st., a povremeno se javljaju i kasnije, u srednjobizantsko doba, tijekom 10. i 13. st.

Katalog je koncipiran na pet poglavlja, od kojih se četiri temelje na tehnikama proizvodnje posuđa, a peti na raznolikim staklarskim izrađevinama; to uz daljnje detaljnije podjele. Svaki kataloški broj, od prvog do petstodevetog, je elaboriran, od naziva, datacije, materijala i dimenzija, načina nabave za Muzej, mjesta proizvodnje, podrijetla, tehnike oblikovanja, tehnike ukrašavanja, stanja, opisa, komparativnih primjeraka, odnosno objave do kolor

pagan motifs. Among other hypothesis, they are thought to be gifts given to remember formal occasions like wedding and anniversaries of assuming public functions. The technique used to insert the thin sheet of gold leaf onto the inner part of a bottom of an open vessel is still unclear. The desired depiction was engraved into the gold and some details were occasionally highlighted in color. The second glass parison would then be blown inside the reheated vessel. The new layer of glass would tie itself to the vessel walls, thereby protecting the golden decoration between layers of transparent glass. In the 6th cent., this technique was used to make tesserae, crusts, plaques, wall revetments.

Glass ware with *indentations* formed with the help of pincers on a heated vessel was probably, like pottery ware, an imitation of metal prototypes. This free-blowing decorative technique was known since the 2nd half of the 1st cent., and was frequently used between the 2nd and the 4th century.

Pinching with the help of pincers was used to create surface protrusions, the, so called, fins, on the body of the vessel and sometimes served as the bottom. This technique is characteristic of the eastern Mediterranean at the end of the 2nd cent., was widely used since the 5th cent., and, at least in Jordan and in Syria and Palestine, until the 8th century. Similar vessels with thicker and more regularly arranged fins were probably formed by mold blowing during the 3rd and the 4thg centuries. A similar, but more complex decorative pattern of vertical ribs or rhombs, called bifurcated or *fadendekor*, was made by pinching from the neck to the bottom of the vessel before its body was finally formed.

Bicolor decoration, known since pharaoh Egypt, throughout classical Greece and in Roman and Medieval times, was achieved by using two or more colors of glass. Mostly handles, the bottom and applied decorations were formed from vividly colored glass, different from the color of the body.

Painted decoration, like gilding, was a rarely used technique in late Classical Greece and Hellenism. Richly painted vessels appear more frequently in the 4th quarter of the 1st century. The paint, made out of a kind of glass enamel paint of pulverized glass in the desired color mixed with water, would fuse with the heated glass surface.

Specimens of gilded ware and plaques from the 1st and the 2nd centuries were painted after annealing by applying gold leaflets on the surface which was then decorated by engraving. Vessel lids were also painted when cool in the 3rd and the 4th centuries and, for protection, on the inner side. All listed techniques were sued in the 3rd and the 4th centuries

fotografije. Slijede crteži složeni jednostavno prema rednim, odnosno kataloškim brojevima predmeta.

Iza navedenih *kratica*, *literature* i *konkordancije* inventarnih brojeva s kataloškima, slijedi i te kako koristan *indeks* imena, mjesta i tipova posuđa s tehnikama oblikovanja i ukrašavanja. Na kraju su navedeni autori fotografija: Bruce M. White, crteža: Chrysoula Mallia, Elliot Lopez-Finn, Class of 2012 i Nicholas McAfee, Class of 2013, te karte: Anandaroop Roy, kao i izvori ostalih korištenih likovnih priloga.

Ova je knjiga uzoran kompendij o antičkom, *odnosno rimskom* staklu, i vrijedan pomoćnik u analizi pojedinih staklenih oblika na čast autoru i njegovu timu, a na zadovoljstvo svim korisnicima.

and occasionally appear later, in middle Byzantine times during the 10th and the 13th century.

The *catalogue* has five chapters, four based on production techniques and one with various glass artifacts; with further divisions. Each catalogue number, from the first to the five hundred and ninth, is elaborated and contains a name, datation, material and dimension, the way it arrived to the Museum, state, description, comparative examples, publications and photographs in color. It is followed by drawings arranged by the catalogue numbers.

The list of *abbreviations, bibliography* and the *concordance* of inventory and catalogue numbers is followed by a very useful *index* of names, places and types of vessels with forming and decorative techniques. At the end, there is a list of photography makers: Bruce M. White, drawing makers: Chrysoula Mallia, Elliot Lopez-Finn, Class of 2012 and Nicholas McAfee, Class of 2013, as well as map makers Anandaroop Roy, along with the sources of other illustrative appendices used in the text.

This book is a precious compendium about ancient, *i.e. roman* glass, and it provides valuable help in analyzing individual glass forms, it is also a pride to the author and his team, and a pleasure to all readers.