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THROWN AWAY OR PUT AWAY? WINDOW GLASS FROM THE SECOND HALF OF THE 17TH CENTURY DEPOSITED IN TYKOCIN CASTLE, POLAND

Abstract: This study is dedicated to window glass discovered in Tykocin castle, deposited in the northern part of the complex, most probably dated to the 1660s. These are remains of windowpanes prepared for the glazing of windows during refurbishment and construction work in the castle building following its destruction in 1656. This paper contains descriptions of those finds including formal, metric and morphological features of the material, structure of the surface and evidence of technical procedures, the character of finds and the reason for the creation of the glass deposit. Finally, the paper discusses the time and circumstances in which the said glass was treated and processed.

Keywords: Tykocin Castle, post-medieval glass, glass archaeology, studies on glass, windows, windowpanes

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Introduction

Windowpanes are building material in the form of a permanent screen that lets sunlight inside but at the same time protects interiors against external weather conditions. The wider use of window glass and the increase in demand for such items was associated with the development of architecture and material culture, especially constructing large religious buildings, in which the size of windows was gradually becoming bigger and bigger. Other materials that had similar use, such as animal membranes, antler, parchment, marble, alabaster or mica plates became unsuitable for that purpose because they were not sufficiently durable and transparent or because of their high cost.[1]

In the territory of Poland window glass was known and used already since the early Middle Ages, and definitely in the 14th and 15th centuries. Since the 16th century it was already a common item.[2] This is evidenced by a variety of sources – written records, iconography and archaeological finds. Polish documents from the late Middle Ages and the post-medieval period, when referring to glazed windows, usually use the term "błona" (Lat. *membrane*). However, glass did not fully replace other, simpler and cheaper, materials, which were still used to protect window openings – primarily paper or linen. Furthermore, windows without any filling, i.e. closed only with shutters, also continued to be used.[3] In monumental buildings, where windows were one of key architectonic elements determining the form, aesthetics and functionality of the structure, it was necessary to use glass with appropriate technical parameters – as clear and transparent as possible. Glass with such properties was hard to manufacture in rather small and primitive glass workshops that dominated in Poland in the 16th and 17th centuries, commonly referred to as "forest glassworks", which usually functioned only for a short time and depended on local, easily accessible

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[1] Wyrobisz 1968, 107-108.

[2] For instance, Dekówna 1992; Wyrobisz 1992.

[3] See Wyrobisz 1968, 108-123.

Fig. 1. Site plan showing relics of the castle and roundels in Tykocin unearthed during archaeological excavations in the years 2001-2007. The arrow points to the location of the deposited window panes from the second half of the 17th c. Key: 01-30 – excavation trenches; N01-N08 – watching briefs; dotted line – reconstructed outline of the roundels that functioned from the third quarter of the 16th c. to around second decade of the 17th c. Prepared by W. Bis.

raw material and fuel resources.[4] Thus, in such situations foreign glass was used, imported from reputable glassworks, which produced glass with desirable features, for instance Venetian or French workshops.[5]

At the same time, broken and worn glass items were collected and stored as raw material, which was sold or exchanged for new goods. Collected glass shards were sent back to glassworks.[6] Until the 18th century, glass cullet (which came from the same given workshop or was supplied externally) was an indispensable element for smelting glass in the furnaces of that period, which were fired directly with wood,[7] being an ingredient technologically required for the production of new glass. For this reason, it is possible that glass artefacts were recycled many times.

Iconographic sources in the form of depictions of windows, although helpful and used in studies concerning construction elements described here,[8] are not always true representations of actual historic facts, as they often follow and multiply certain artistic conventions or are only schematic depictions of the past, whereas descriptions of buildings recorded in archival documents, for instance inspections, inventories or registers, mainly refer to the state of preservation, possibly the number, structure and the type of filling of the windows, and usually do not include any information about properties of windowpanes themselves. Therefore, in the light of the ambiguity or enigmatic nature of surviving descriptions and images, to reconstruct former window glass we need period windows with original glazing and archaeological finds. Unfortunately, windows from the 16th and 17th centuries are extremely rare in Poland. However, archaeological finds – their material remains – especially those from the post-medieval period, are discovered often and in large quantities.

An example of a monumental building with many glazed windows is the castle located in Podlasie region[9],

[4] For instance, Wyrobisz 1992, 411.

[5] Wyrobisz 1968, 124, 181-189; Wyrobisz 1974, 56.

[6] Data concerning this topic come primarily from 16th century written records from Kraków, Wyrobisz 1968, 177-178.

[7] Wyrobisz 1992, 413; Lichota 2004, 41.

[8] See Frycz 1972; Markiewicz 1995; Darecka 2016, 49-53.

[9] More information on this topic can be found in next parts of this paper.

Fig. 2. Tykocin Castle. Context 04 in trench 18, in which window glass was deposited, during excavations in 2003. Photo W. Bis.

in north-eastern Poland, on the Narew River, just opposite the town of Tykocin. The aim of this paper is to present the assemblage of windowpanes deposited in one place during that castle's functioning and describe and characterise those glass finds. One of key research objectives is to explain reasons for the creation of the said deposit and establish whether glass from the assemblage was used around the time of its deposition, and if so, when this took place. This paper also attempts to propose a possible reconstruction of windows from the Tykocin castle based on the analysed archaeological material.

Location of the assemblage, research methods

Glass finds that are the subject of this study were discovered during archaeological excavations carried out in the Tykocin Castle in 2003. They were recorded in a trench located in the northern part of the castle complex (trench number 18), outside the external line of caste buildings arranged in a quadrangle, planned diagonally to cardinal directions (Fig. 1). The assemblage was discovered in a sandy layer (number 04) that contained small fragments of lime mortar and brick rubble, on average 20 cm thick (Fig. 2). That context was dated generally to the period between the second half of the 17th century and the second half of the 18th century, and was counted among archaeological layers that constitute the sixth chronological level, i.e. the sixth of seven phases in the history of the Tykocin Castle complex.[10] At the same time, the stratigraphic context indicated that layer 04 was undeniably created at the beginning of that period.

That layer contained in total 1304 fragments of window glass.[11] This is the largest assemblage of this type of finds discovered during archaeological investigations on this site,[12] constituting nearly 26% of all retrieved window glass fragments (i.e. 5042), but only a small fraction of all archaeological finds – 1.4% (of 91757 artefacts in total).[13] The main advantage of those finds compared to other window glass specimens found in the area of the Tykocin complex is their rather large number and the fact that they constitute a uniform and rather well-dated assemblage. The remaining window panes usually survived in a much small number of fragments deposited in individual archaeological layers (usually several – a dozen or so fragments, with the maximum of 600 in one case), are shattered into many small pieces or come from backfill strata.

[10] Its characteristics can be found in: Bis 2015, 79, Table 1 and 96-97.

[11] In the inventory of finds the total number of window glass fragments was established as 1316 pieces. However, as a result of the subsequent analysis 12 of those finds were identified as remains of glass vessels. Furthermore, context number 04 contained 331 other finds, including: 9 further glass vessels and 173 fragments of pottery artefacts (vessels: greyware, redware, glazed redware, glazed whiteware, majolica, vessel tiles and panel tiles), as well as animal bones (146) and metal finds – parts of knives and lead plates.

[12] Excavations were carried out in the years 1961-1963 by a team led by Jerzy Kruppé, and from 1999 to 2007 by Magdalena Bis and Wojciech Bis.

[13] See Bis 2015, 96-97, Table 2.

Retrieved glass finds were subjected to a macroscopic analysis and examined under a magnifying glass in accordance with the rules and description created for this type of artefacts by Jerzy Olczak,[14] as supplemented by Maciej Nawracki.[15] The analysis included formal features of the examined artefacts such as: their shape, type of edges and the state of preservation, metrical and morphological features of the material (degree of transparency, colour, flaws in the glass mass – bubbles, inclusions, smudges), properties concerning structure of their surface and evidence of processing/manufacturing activities. All properties were recorded in a dedicated study chart (created by the author on the basis of the above-mentioned guidelines and supplemented by the author in line with the specific character of the analysed assemblage). Individual finds recorded in the database had their unique entries. Results of the totalling and comparing of the observed and recorded properties became the basis for formulating conclusions presented below.

In order to specify the type of glass used for the production of glass panes, six fragments with a suitable state of preservation, i.e. with a small number of changes caused by corrosion, were selected for laboratory analyses. Samples were subjected to the X-ray microanalysis (EPMA – *Electron Probe Microanalysis*),[16] which currently is one of key methods used for the identification of chemical composition of materials, including archaeological glass.[17] In the case of each sample, 5-6 single-point analyses were performed with regard to 24 components[18] with 2-3 BSE (*Backscattered Electrons*) photographs taken for every sample. Finally, in determining the type and variety of glass rules for classification of results of the chemical analysis of the composition commonly used in Polish archaeological publications were applied.[19]

Characteristics of finds

It was established that all analysed glass fragments (i.e. 1,304 pieces) came from glass panes (Figs. 3-6). Their state of preservation is not very good. The assemblage contained only a few complete panes, or panes for which it was possible to recreate their original shape and size (106 in total, i.e. 8.1% of the entire assemblage). There were also many fragments preserved with more than one original edge (827 pieces, i.e. 63.4% of all recorded finds) and glass that is non-characteristic and fragmented to the degree which makes its reconstruction impossible (371 pieces representing 28.5% of the assemblage). The latter group was excluded from the discussion concerning the shape and original size of glass panes and the reconstruction of glazing, although – except for items destroyed by corrosion – their technological features were recorded: transparency, colour and flaws of the glass.

The size of glass varies, although the dominating group are medium size artefacts with a surface between 4.1 and 6 cm^2, constituting almost a half of all finds (48.7% of the assemblage). There were fewer small finds – with a surface between 2.1 and 4 cm^2 (36.9%) and large ones, characterised by a surface between 6.1 and 8 cm^2 (9.6%). There was only a small percentage of extremely small or large finds – with a surface of 2 or less cm^2 (3.5%) and over 8 cm^2 (1.3%) (see Table 1). By summarizing those parameters, it is possible to state that the analysed glass fragments would create a sheet of glass with a surface of around 5,800 cm^2, i.e. approximately 0.6 m^2.[20]

WINDOWPANE GLASS (PRESERVED COMPLETE AND IN FRAGMENTS)			
SIZE		NUMBER	PERCENTAGE
SURFACE	CATEGORY		
≤ 2 cm^2	very small	46	3.5
2.1 – 4 cm^2	small	482	36.9
4.1 – 6 cm^2	medium	634	48.7
6.1 – 8 cm^2	large	125	9.6
≥ 8.1 cm^2	very large	17	1.3
Total		1304	100

Table 1. Windowpane glass from Tykocin Castle according to the size category. Compiled by M. Bis.

[14] Olczak 1983, 121-123.

[15] Nawracki 1995, 214-215; Nawracki 1999, 60-62, 95-98 and Table 9.

[16] EPMA analyses of glass panes were carried out by Dr Beata Marciniak-Maliszewska in the Inter-Institution Laboratory of Microanalysis of Minerals and Synthetic Substances Institute of Geochemistry, Mineralogy and Petrology Faculty of Geology, University of Warsaw. The analysis used an electron microprobe Cameca SX-100 with a tungsten cathode, equipped with four WDS spectrometers (*Wavelength Dispersive Spectroscopy)* and an EDS (*Energy Dispersive Spectroscopy*) spectrometer. Analyses were performed under high vacuum, with an accelerating voltage of 15 kV, current of 10 nA and the width of the electron beam of 10 µm (for more information about this method see, for instance, Dekówna and Purowski 2012, 66-68).

[17] For instance, Dekówna and Purowski 2012, 66-68; Kokora 2019, 191-192; Purowski 2019, 29-30.

[18] Some components were not detected, because either they were not present in the analysed glass or their concentration was too low, below the detection point for this method (see Table 2).

[19] Colladet, *inter alia*, in: Dekówna and Purowski 2012, 68-173.

[20] According to glazier Józef Torzewski, who wrote down and in 1785 published his memories and thoughts concerning the many years of his professional experience in the Chudniv glassworks in Ukraine, a formed sheet of glass "should be as big as a half of a sheet of *Regalpapier"* [good quality paper with the largest size of sheet]. Such glass panes, referred to as "box panes", were stored in crates called boxes, usually "in bundles of 120", Torzewski 2002, 88.

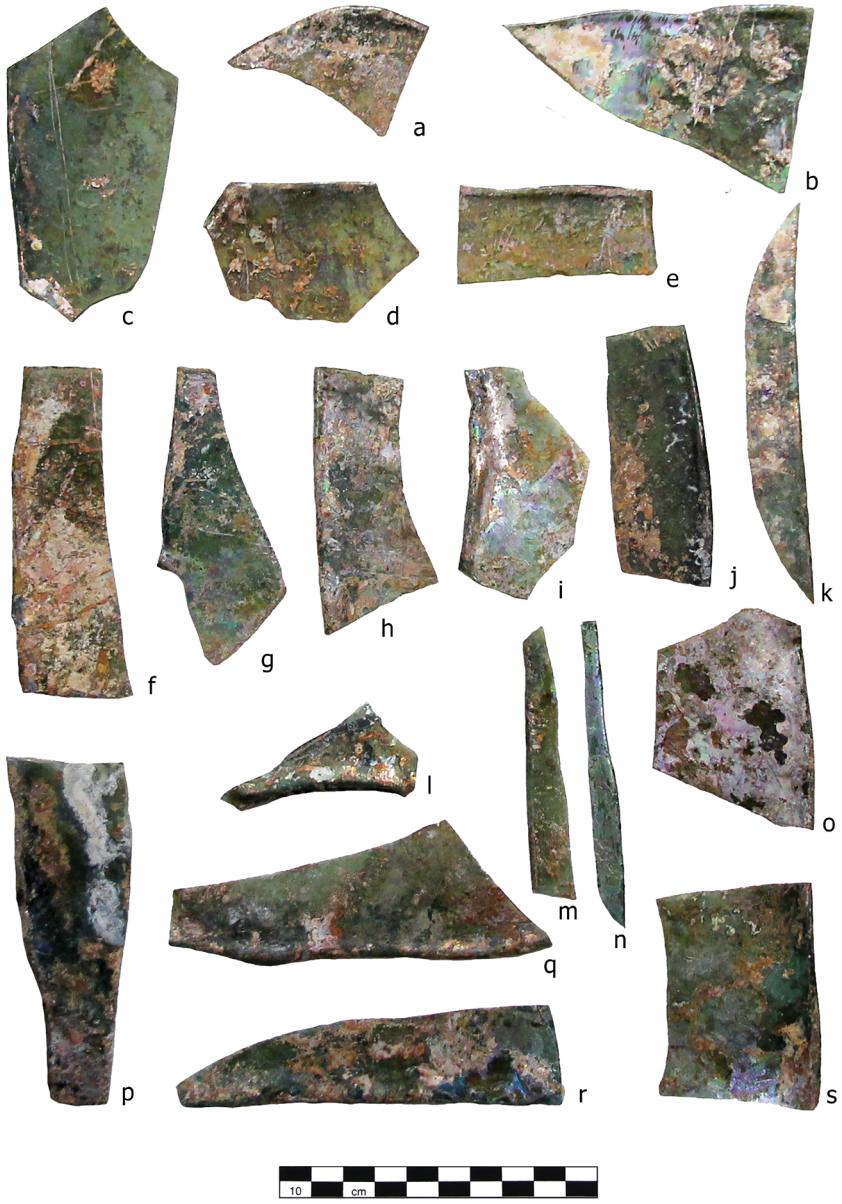


Fig. 3. Tykocin Castle. Windowpane glass and fragments thereof from the second half of the 17th century. Finds with preserved edges of sheets of glass. Photo and digital processing W. Bis.

The process of corrosion affected in a varying degree of intensity almost 86% of finds. Visible signs of corrosion are manifested in the form of a yellowish-brown or white patina and a splintering layer of iridescence. This limited the possibility of drawing conclusions about technological properties of the analysed artefacts and made it difficult to identify internal structure of glass fully. At the same time, the number of fully damaged or very well-preserved glass panes was very small (around 1% in both cases). For this reason, observations were made only in the case of approximately 14% of finds. It was established that initially the said glass was translucent and clear. When examined against the light, it had a green colour, mostly with a light, sometimes a bit darker, hue. Observations made with the naked eye and under the magnifying glass revealed flaws of the glass mass on the external surface of artefacts or just below the surface, which were the evidence of technical treatment. There were only a few finds without such flaws. The rest was characterised by the presence of colourless bubbles - scattered or concentrated - which were cavities filled with gas. These are one of different defects that occur as a result of a non-clarification of the glass mass or emission of gasses during production. A small number of such flaws does not significantly affect the mechanical strength of glass but worsens its aesthetic

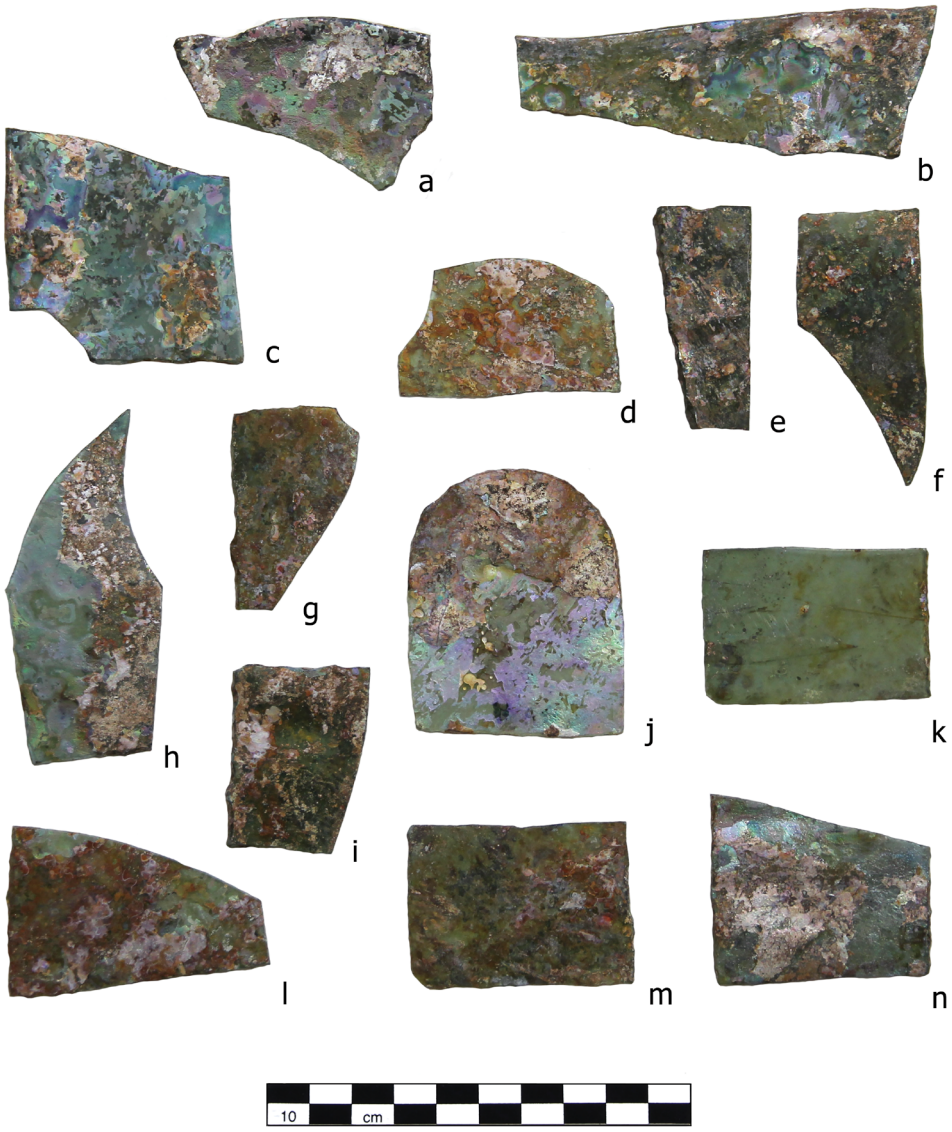


Fig. 4. Tykocin Castle. Windowpane glass and fragments thereof from the second half of the 17th century. Finds with retouched edges. Photo and digital processing W. Bis.

properties.[21] Window glass described in this paper contained, in terms of their size, mostly small bubbles (smaller than 1 mm), in large numbers (i.e. from 2 to 5 bubbles per 1 cm^2). Recorded twice less often were medium size bubbles (1-3 mm), in large (2 to 5) or very large numbers (over 5) per 1 cm^2 of the surface. Sporadically there were also very big bubbles (measuring over 3 mm), usually many. Sometimes one glass fragment contained bubbles of different sizes – large and small. The shape and distribution of bubbles, irrespective of their size, was similar – usually lentoid or round. If we assume that one of the edges of the glass pane was its vertical centre line, the arrangement of bubbles in relation to the axis was described as diagonal or parallel. There were several occurrences of various crystalline inclusions, which were impurities of the glass mass.[22] The above-mentioned properties determine the assessment of glass in terms of the degree of transparency and uniformity (clearness). Thus, the discussed glass panes can be classified as average.

Windowpanes from Tykocin are characterised by a usually smooth surface (93%). Only in a few cases (7%) their surface was uneven – slightly rough. This

[21] Nowotny 1975, 318-319.

[22] Nowotny 1975, 320-321.

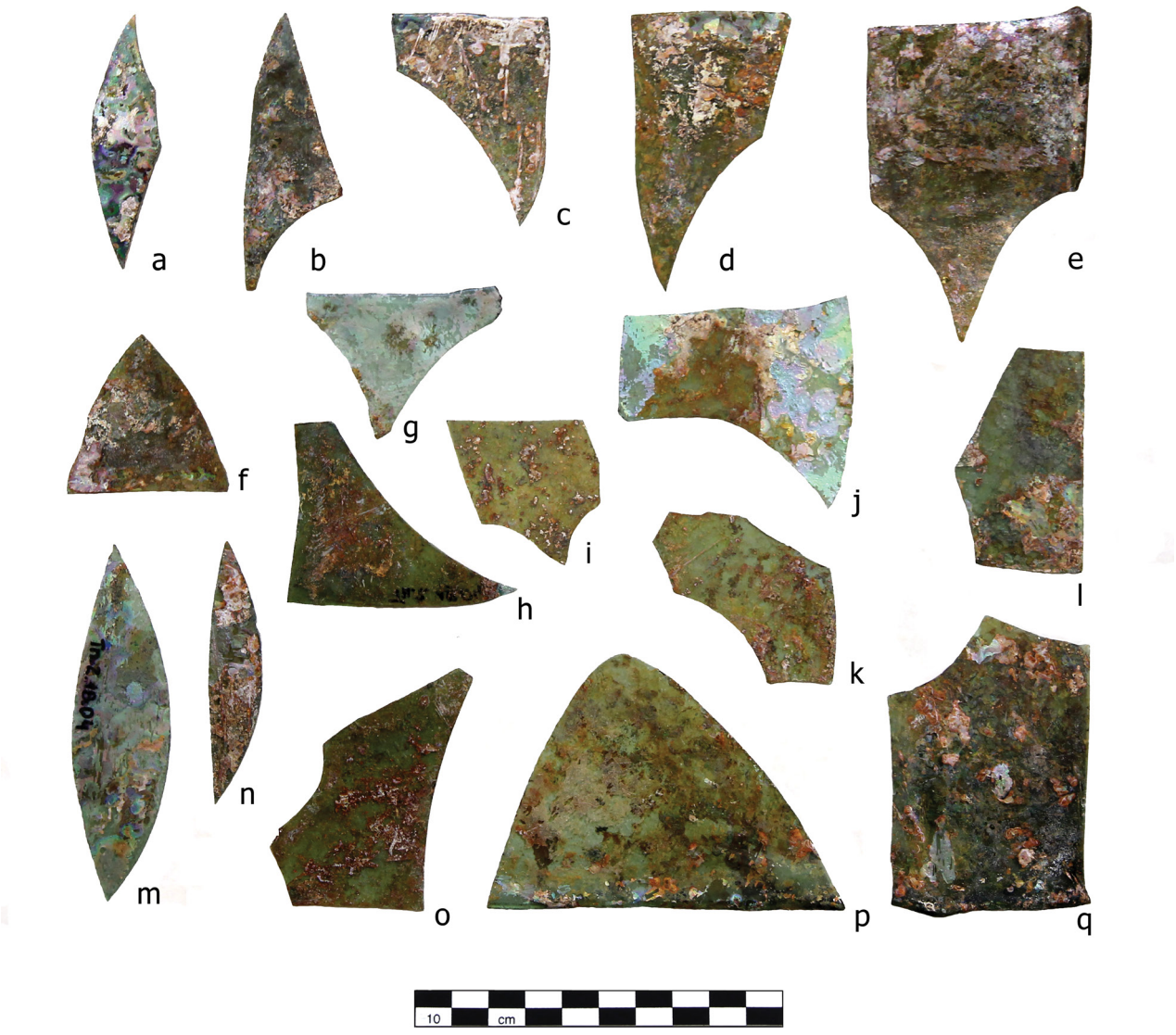


Fig. 5. Tykocin Castle. Windowpane glass and fragments thereof from the second half of the 17th century. Finds with edges that were cut off. Photo and digital processing W. Bis.

was a deformation of glass sheets, from which the analysed windowpanes were made – a manufacturing flaw.

The thickness of the glass ranged from 1 mm to 5.5 mm. Such large disproportions are the result of the greatest thickness being 3.5-5.5 mm, which were observed near the original edge of the glass sheet preserved in the case of a large number of finds (in total, 438 such glass fragments were recorded, which constitutes 1/3 of the entire assemblage) (Fig. 3:a-s). Edges of sheets of glass were rounded and thickened. Such edges survived on a number of finds from Tykocin, usually with the length of several centimetres, sometimes over 10 cm, but no more than 13.3 cm (Fig. 3:k). It was observed that the thickness of the glass gradually decreased towards the centre of the glass sheet and over a distance of several centimetres reached between 2.5 and 1 mm, i.e. decreased by a half. The thinnest, and thus the most fragile fragments, forming central parts of glass panes, were only 1-1.5 mm thick. They were also the most brittle finds and survived mainly in the form of the smallest glass fragments. This range of thickness may be treated as the characteristic feature of the analysed window glass.

Based on the analysed fragments, the thickness of the original edge of the sheet of glass determined its further use. If the thickness was equal and below 3 mm, it was cut and served as one of the edges of a new windowpane (Figs. 3:b-e; 4:a-b and 5:e, p-q). Where it

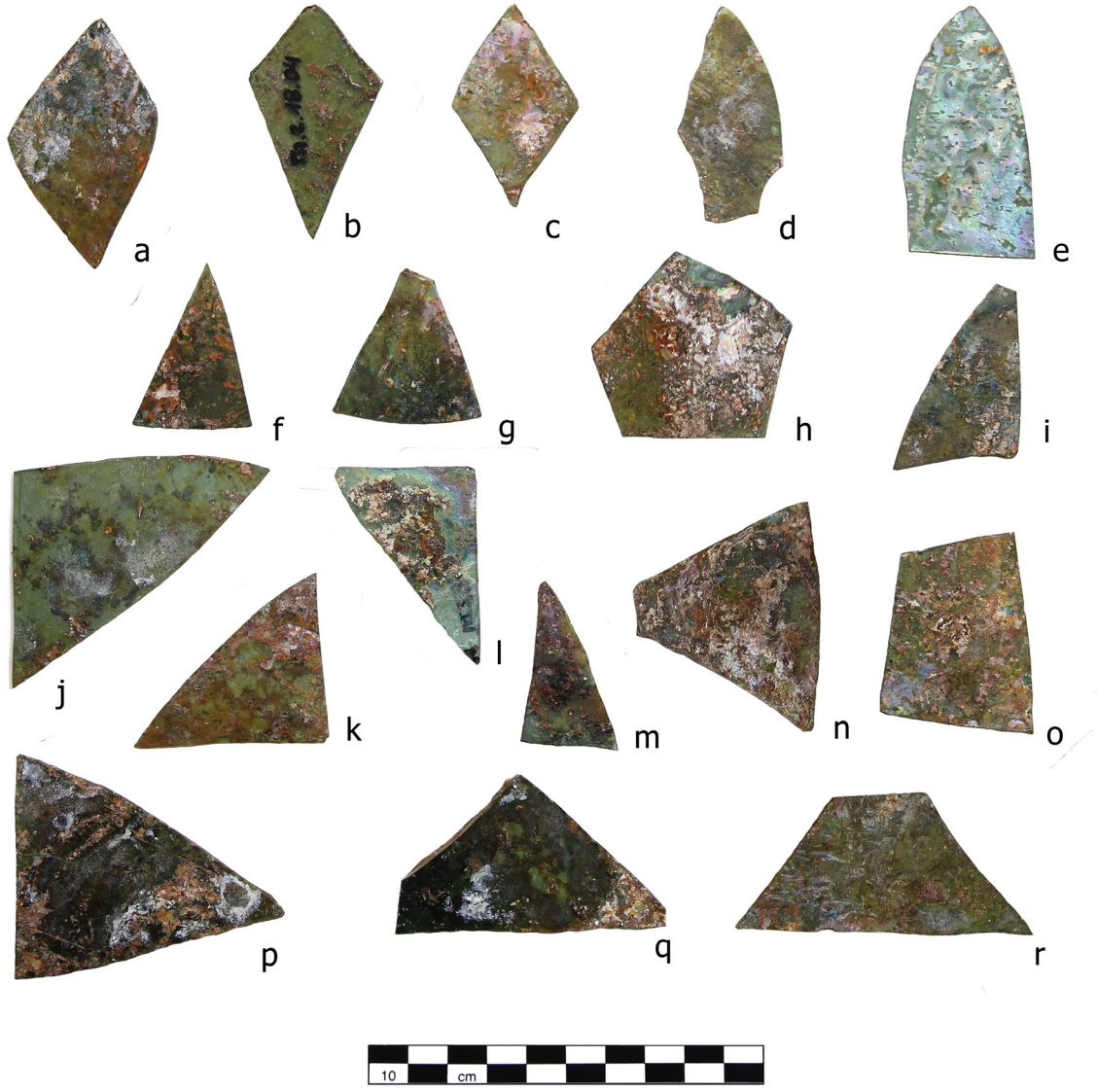


Fig. 6. Tykocin Castle. Windowpane glass and fragments thereof from the second half of the 17th century. Finds with edges that were cut off. Photo and digital processing W. Bis.

exceeded 3 mm, it was cut off and left in the form of trimmings of different width (Fig. 3:a, f-h, k-l). The former group of finds contained the greatest number of big glass fragments (having the largest surface in the entire assemblage), i.e. fragments with a surface of over 8 cm^2 (17 pieces). In one case the edge of the glass sheet was curled along a small section, and that part was cut off. Its thickness in this spot was as much as 7 mm; this value was created by a double sheet of glass: 3.5 mm thick each (Fig. 3:l). One piece of glass had a lentoid hole near the edge, with a diameter of 1 cm. That fragment was also cut off and became a useless scrap.

Many glass fragments (around 45%) had scratches in the form of various lines, single or double, which means that the glazier using a sharp blade marked cut lines corresponding with future shapes of elements he was preparing (Fig. 3:c-g). Those scratch marks are at the same time the evidence of failures and errors made during the preparation of glass panes – of glass breaking off near the marked line and creating glass panes with asymmetrical edges. Breaking of the glass also not always went according to plan, which resulted in uneven edges.

Cutting was used to give glass panes correct shapes. The analysed specimens[23] represented nine types:

[23] Presented below are the dimensions of artefacts with the most regular edges, in the case of which there was the greatest probability of determining their original dimensions.

- triangular (36 items in total) – in the shape of a right-angled triangle (18) (Fig. 6:i, k-m), with angles of 30-90-60° and 45-90-45°; isosceles triangle (12 items) (Fig. 6:f, g, p, q): 75-30-75° and 70-40-70°; and equilateral triangle (6): with the length of sides of around 4 cm;
- trapezoid (19 items) – with a form close to isosceles, with the length of sides of: 2 × 4 × 4.4 × 7.4 cm or rectangular: 5.2 × 7.1 × 3.9 × 4 cm (Fig. 6:r);
- rectangular (14 items) – only their width was determined: between 4.4 and 6 cm, although usually 5.2-5.6 cm (Fig. 4:k-n);
- arched (12) – including one completely preserved windowpane, which is a finished good quality product that had not been used for an unknown reason during the preparation of panes, arched at the top (with a diameter of 5 cm) and rectangular in its lower part (with a base equal of 5 cm, and sides 4.6 cm long) (Fig. 4:j). Other, similar panes had an arch of: 6 cm, 8 cm, and 9 cm. This group includes also arch-shaped elements, some wider, others narrow, with a base of 3.8 cm, and height of 6.2 cm or 6.5 cm (Fig. 5:f) and with a base of 9.7 cm and height of 6.6 cm (Fig. 5:p);
- irregular (13) connected with arched elements (Fig. 5:a-e, i-j, k, q);
- deltoid panes (7) – with angles of: 80-110-60-110° (Fig. 6:b-c);
- spindle-shaped (2) – with a length of 8.3 cm and the maximum width of 2.6 cm, and respectively: 6 × 1.3 cm (Fig. 5:m, n);
- pentagonal (2 items), with sides of the following length: 2.5 × 3 × 3.3 × 3.7 × 3.7 cm or 2.8 × 3 × 3.8 × 1.4 × 6 cm (Fig. 6:h); and
- rhomboid (1), with angles of: 115-65-115-65°.

In the case of glass that survived only in fragments and there were no grounds for recreating their form, the author identified specimens that had at least one original edge (827) – usually straight (393), arched (204), diagonal (103) or irregular (127). In the group of specimens with straight edges several dozen made a corner (69).

The next stage of work, effects of which were observed on the analysed finds (in total 136 specimens constituting 10.4% of the assemblage), was the retouching (flaking) of edges of cut out windowpanes, to facilitate mounting them in lead cames.[24] It was established that retouching was done only on one side, with a tool pointing straight or at an angle – a heated metal rod. Only a few panes were retouched on all edges (Fig. 4:j), however, usually that procedure was applied to just two or only one of the sides. Sides were usually retouched along the entire edge but sometimes also only partly. Such treated and prepared elements were easier to match with each other and with the came that joined them.

None of the fragments had traces of decoration in the form of painting or engraving.

Interpretation and dating of finds and the provenance of glass

One of the key questions that needed to be answered by the analysis presented in this chapter was the manner in which the glass was manufactured. In the case of glass panes, features that are unequivocally deemed to be associated with the technique in which glass was formed, are the shape and the arrangement of bubbles (these were recorded on the majority of finds). Through indirect analysis and based on information provided by written records it is assumed that they were made by hand, by blowing glass cylinders, i.e. from a glass bubble of an adequate size and shape, ends of which were cut off, with the body later cut along its longer axis. Then, the glass was heated up in a furnace and straightened to shape a flat sheet.[25] Such sheets of glass were used as a half-product for cutting out panes of a desired shape. Due to its properties, the glass analysed in this paper can be classified as the so-called simple, ordinary glass panes, mostly colourless-greenish.[26]

Based on the EPMA analyses (Tables 2 and 3),[27] it was possible to determine the chemical composition and type of glass used to produce sheets of glass discovered in Tykocin. It was a lime-potassium-magnesium-aluminium-silica glass ($CaO•K_2O•MgO•Al_2O_3•SiO_2$), characterised primarily by the high content of calcium oxide (CaO from 22.217 to 25.532%) and potassium oxide (K_2O between 5.496% and 9.022%), and a low concentration of sodium oxide (Na_2O from 0.474 to 0.914%). These results indicate that it was a low-alkaline glass.[28] It is characterised by the optimal concentration of magnesium oxides (MgO between 3.403 and 4.422%) and aluminium oxides (Al_2O_3 between 2.505

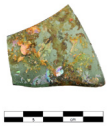
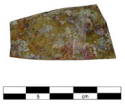
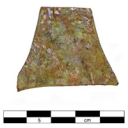
[24] Olczak 1983, 116-117.

[25] Reconstruction of that manufacturing process for instance in: Olczak 1983, 117; Dekówna 1992, 398-399, Fig. 6; Kaufmann 2012, 190, Fig. 6; 193, Fig. 10.

[26] Lichota 2002, 158, key word: *huta szklanna robiąca proste (ordynaryine) szkło*.

[27] Table 2 presents results of 3 analyses performed for each sample, expressed in the form of oxides in weight percentages and average values computed on their basis (marked in grey). Average results were used to compute totals and proportions of main components of glass presented in Table 3.

[28] For instance, Girdwoyń and Rubnikowicz 1996, 454; Mucha 2000, 261; Wilczak-Dąbrowska 2017, 111.

SAMPLE	PICTURE OF THE WINDOW-PANE	TRASPAR-ENCY AND COLOUR OF GLASS	ANALY-SIS	OXIDES [wt. %]											OTHER COMPO-NENTS*
				SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	Fe_2O_3	MnO	P_2O_5	BaO	SO_3	
Windowpane No. 1		transparent, green	lab1	56.037	0.699	6.219	23.204	3.55	2.705	1.13	1.495	2.965	0.436	0.161	<
			lab2	55.985	0.683	6.365	23.296	3.524	2.808	1.016	1.198	2.959	0.394	<	<
			lab4	56.071	0.68	6.483	23.379	3.53	2.846	1.102	1.269	2.797	0.397	<	<
			average	56.031	0.687	6.355	23.293	3.534	2.786	1.082	1.32	2.907	0.409	0.161	<
Windowpane No. 2		transparent, light green	lab8	55.136	0.608	8.112	22.38	3.744	3.232	0.913	1.14	2.681	0.352	<	<
			lab9	55.141	0.677	8.026	22.217	3.812	3.157	1.288	1.157	2.473	0.416	0.285	<
			lab10	54.787	0.632	7.928	22.283	3.761	3.094	1.111	1.368	2.529	0.427	0.337	<
			average	55.021	0.639	8.022	22.293	3.772	3.161	1.104	1.221	2.561	0.398	0.311	<
Windowpane No. 3		transparent, green	lab11	52.086	0.628	8.664	24.236	4.205	2.807	1.067	1.307	2.942	0.393	0.248	<
			lab12	51.411	0.914	8.792	24.666	4.099	2.832	1.128	1.301	2.789	0.386	0.278	<
			lab15	50.357	0.613	9.022	25.532	4.422	2.653	0.847	1.492	3.063	0.466	0.385	<
			average	51.284	0.718	8.826	24.811	4.242	2.764	1.014	1.366	2.931	0.415	0.303	<
Windowpane No. 4		transparent, light green	lab18	53.692	0.665	6.53	25.092	3.907	2.505	0.941	1.544	2.637	0.337	0.183	<
			lab19	53.741	0.688	6.588	25.063	4.004	2.399	1.019	1.617	2.718	0.496	0.211	<
			lab21	53.644	0.474	6.909	25.219	3.94	2.515	0.861	1.549	2.492	0.546	0.158	<
			average	53.692	0.609	6.675	25.124	3.95	2.473	0.94	1.57	2.615	0.459	0.184	<
Windowpane No. 5		transparent, greenish	lab22	56.586	0.571	5.495	23.53	3.45	2.719	1.101	1.443	2.802	0.324	0.257	<
			lab24	56.743	0.548	5.498	23.32	3.455	2.658	1.006	1.543	2.755	0.458	0.223	<
			lab25	56.594	0.743	5.558	23.483	3.371	2.651	0.961	1.614	2.719	0.377	0.229	<
			average	56.641	0.62	5.517	23.444	3.425	2.676	1.022	1.533	2.758	0.386	0.236	<
Windowpane No. 6		transparent, greenish	lab30	57.471	0.575	5.527	23.128	3.403	2.737	0.909	1.5	2.649	0.485	<	<
			lab31	57.231	0.673	5.496	23.377	3.495	2.743	0.748	1.633	2.561	0.446	0.311	<
			lab32	57.704	0.538	5.498	23.201	3.45	2.677	1.071	1.473	2.603	0.42	0.342	<
			average	57.468	0.595	5.507	23.235	3.449	2.719	0.909	1.535	2.604	0.45	0.326	<

* Sb_2O_3, PbO, CoO, CuO, TiO_2, NiO, ZnO, Ag_2O, Au_2O_3, V_2O_5, Cr_2O_3, ZrO_2, Cl – components performed in every analysis but not present in glass or with low concentration, below the detection point for this method ("<")

Table 2. Results of the analyses of the chemical composition of selected window glass from the second half of the 17th century deposited in the area of the Tykocin Castle performed with the EPMA method.

PROPORTIONS AND SUMS OF THE KEY GLASS COMPONENTS*	SAMPLE					
	Windowpane No. 1	Windowpane No. 2	Windowpane No. 3	Windowpane No. 4	Windowpane No. 5	Windowpane No. 6
K_2O/Na_2O	9.25	12.553	12.292	10.96	8.898	9.255
K_2O+Na_2O	7.042	8.661	9.554	7.284	6.137	6.102
CaO/MgO	6.591	5.909	5.848	6.359	6.483	6.738
CaO+MgO	26.827	26.062	29.052	29.07	26.865	26.689
$(K_2O+Na_2O)/(CaO+MgO)$	0.262	0.332	0.328	0.25	0.228	0.228
Al_2O_3	2.786	3.161	2.764	2.473	2.676	2.719

* on the basis of average values from Table 2

Table 3. Proportions and sums of the key glass components in window glass from the second half of the 17th century deposited in the area of the Tykocin Castle. Prepared by M. Bis.

and 3.157%), which give the glass mass a number of favourable properties.[29] The key component is silica (SiO_2, 50.357-57.704%) from quartz sand. The proportion of K_2O and CaO (computed for average values of 0.237 to 0.359) may indicate that the analysed glass was manufactured from a double-content mix – sand and ash.[30] The presence of phosphorus among the glass components (P_2O_5 2.743-3.063%), which facilitated the melting of glass, confirms the use in the melting process of ash made from continental plants, most probably deciduous trees (e.g. beech or hornbeam) or conifers, from ferns or straw from cereals.[31] The translucency and natural greenish hue were the result of the presence of iron compounds (Fe_2O_3 in the concentration of approximately 1%) as mineral impurities of the sand and manganese oxide (MnO usually around 1.5%) included in the ash. The small percentage of barium oxides (BaO, approximately 0.3-0.4%) and sulphur oxides (S_2O_3, approximately 0.2-0.35%), the latter in the form of metal sulphates, may also come from ash. Most probably the content of main components of glass in amounts recorded during the analysis was the result of their presence in the glass mix as natural components of the raw material. At the same time they are the evidence of technological actions taken in the course of the glass production, practised in the post-medieval period in the territory of Poland in the so-called forest glassworks.[32]

None of the analysed specimens had visible evidence of being framed, which is one of arguments determining the nature, and indirectly also the dating, of the said finds. They are windowpanes that were cut out but had not been actually fitted into windows. Thus, those artefacts do not come from older windows, were not taken out as cast-offs during the re-glazing with new panes. Furthermore, scratches on their surface and wobbly, irregular edges of many specimens indicate that most of them were flawed products or scraps created as a result of mistakes or accidental breaking of glass during the preparation of windowpanes. Results of this work – as evidenced by the analysed material – were not satisfactory. Probably glass panes did not fit into the regular intended design of windows or due to their irregularity could not be mounted in a lead came and thus were not used. The fact that they were discarded is at the same time the evidence that the glazier was concerned with the quality, aesthetic look and utilitarian properties of windowpanes he was creating. While making the "membrane" he did not use chipped glass or fragments cut off from the edges of the glass sheet, and thus ensured that the composition of the design remained uninterrupted, and there were no mismatched elements and gaps between them.[33]

The place of deposition of the analysed assemblage was located inside the north-western roundel (see Fig. 1). It is one of the elements that created a line of fortifications of the Renaissance castle built in the third quarter of the 16th century on the initiative and efforts of King Sigismund II Augustus. Roundels functioned for no more than half a century – from the third quarter of the 16th century to around the second decade of the 17th century. It is assumed that it was the time when older fortifications, including roundels, were demolished up to the level of their foundations, to make room for the construction of a more advanced bastion defence system (earth and timber structures further removed from castle walls). The demolition layer that is the evidence of those construction works and the remains of the pulled down buildings which remained blow the ground level were covered with a layer of light-colour sand. Subsequently, next contexts accumulated over those two layers, including context number 04. Work associated with the demolition of old roundels and building new fortifications most probably took place between 1603 and 1613 during the reign of Sigismund III Vasa. Around that time, i.e. in the second or third decade of the 17th century, castle buildings themselves were also modernized,[34] and the castle remained in that form until the "Deluge" - the Swedish invasion. The siege in 1656 (27 January) resulted in the destruction of a part of the castle and the catastrophic consequence of those events were not remedied for the next hundred years, as two of four wings of the castle were destroyed.[35] Only the remaining two parts of the structure – probably the west and the south wing – continued to be used until the final decommissioning of the castle building in the end of the 1760s following the decision of Jan Klemens III Branicki, the owner of the castle at that time, who ordered to have them finally demolished.

Castle buildings that survived the Swedish invasion, to become habitable and serviceable again, had

[29] Mucha 2000, 248, 250.

[30] For instance Stern and Gerber 2004, 137, 150.

[31] Mucha 2000, 249, 263.

[32] Girdwoyń and Rubnikowicz 1996, 454; see also Girdwoyń 1995.

[33] Such requirements: to appropriately arrange glass panes, use only complete panes and not defective ones, create a regular design pattern fitting into the opening that is to be glazed, were set out for candidates during their master craftsman exam for the admission to the guild of Warsaw glaziers according to a by-law of 1551, Wyrobisz 1968, 125.

[34] Those actions probably did not interfere with the size or structure of the existing buildings but were rather limited to making aesthetic changes – adding external decorations and modernizing interiors and improving furnishings. Information on that subject is collected in Bis and Bis 2015, 50-54.

[35] See Bis 2014, 375-376; Bis and Bis 2015, 55-56.

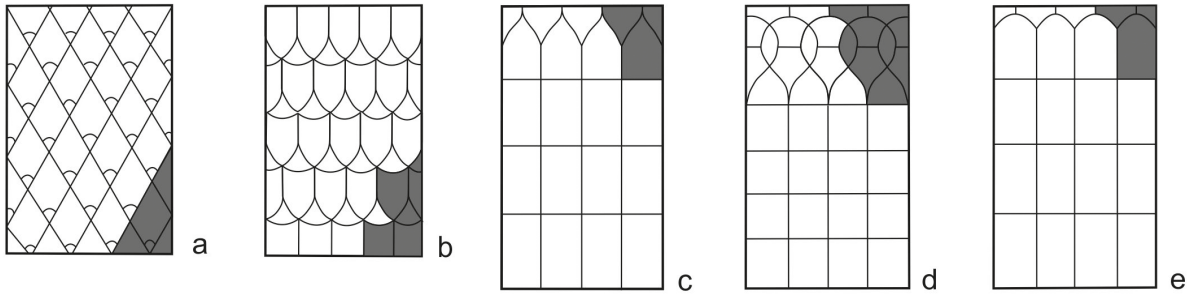


Fig. 7. Geometric glazing (a-b) and brink of rectangular glazing (c-e) with lead cames, most probably used in windows of Tykocin Castle in the second half of the 17th c.; grey colour indicates discovered glass. After Tajchman 1990, Figs. 49A: a-b and 49B: g-i. Digital processing W. Bis.

to be at least repaired to some extent. However, written records do not mention such necessary repair work being carried out. Thus, we may assume that they were performed after the end of the war, when the castle and the neighbouring estates were transferred to Hetman Stefan Czarniecki (through a royal gift in 1661). Soon the castle, through his daughter Aleksandra Katarzyna (in 1665), became the property of the Branicki family of the *Gryf* (Griffin) coat of arms.[36]

For this reason, it is possible that the commencement of repair work aimed at making the castle serviceable took place in the 1660s. This dating corresponds with research findings based on the stratigraphy of the site with regard to the analysed glass in the remains of the roundel – the beginning of the second half of the 17th century. Therefore, assuming that the said finds are waste material associated with the refurbishment of castle windows, this would be the evidence of renovation work being carried out in the caste at least in this respect. It is hard to determine how many windows were glazed with the material cut out from sheets of glass, the remains of which survived as the deposit discussed in this paper. We also do not know how long glass panes that were fitted into castle windows actually functioned and looked like, as so far there are no identified iconographic sources that would be depictions of the castle from the 16th-18th centuries (save for several very schematic plans) or from the 19th century, when the structure was already derelict. Indirect clues come only from some later annotations made in inventors describing the castle. Windows are among architectonic elements mentioned in those accounts, but the information about glass used in them is only partial. For instance, they do not provide any details concerning the type, shape or provenance of windowpanes.[37]

Only by putting together information from the two available categories of sources – written records and archaeological finds – it is possible to some extent to reconstruct properties of the glass used in the Tykocin Castle windows and their potential appearance. Particularly useful in this respect are registers from 1698 and 1701. However, we also need to remember that although their dating is chronologically the closest to the analysed finds, these records still are around 30 years later than the creation of the glass deposit. Currently known written sources do not provide any information about any refurbishment or construction work carried out in the castle building at that time, including the replacing of windows. Records only refer to unspecified damage that the castle suffered in 1674 as a result of a raid by a Lithuanian army.[38] However, most probably that attack did not disrupt the functioning of the castle, which seems to be confirmed by the description of the Tykocin estate from 1676.[39] Thus, probably the majority of windows and glass panes described in both documents functioned since the 1660s.

The above-mentioned accounts provide us, among others, with information how many windows there were in the two wings of the castle that survived from the original quadrangle and continued to be used and maintained at the end of the 17th century and the beginning of the 18th century (i.e. around 44 windows in 20 rooms) and in individual rooms (between 1 and 8). Those written records also mention that windows were divided into panels – usually four in one window, sporadically less (two, three) or more (six) and details that

[36] They held the possession of the castle complex until 1771. This is the date of the death without issue of the last male member of that line of the Branicki family, Jan Klemens III (actually Jan Kazimierz) Branicki. His predecessors as the lords of the castle were: Jan Klemens II (until 1673) and Stefan Mikołaj (in the years 1673-1709), Bis and Bis 2015, 57; biographies of the Branicki family members in, for instance: Zielińska (in cooperation with Gepner) 1997, 33-40.

[37] See Bis 2014, 375-398.

[38] Kochański 2010, 158.

[39] Kochański 2010, 161.

made their design pattern.[40] In most cases windows were leaded, i.e. glass panes were joined together in panels with lead frames.[41] A small evidence of this glazing technique is a piece of a lead plate discovered in the same context as the glass (i.e. number 04). It was most probably material used for making such frame called bolection, which was shaped by the glazier into a double-T bar;[42] it could be drawn (in special devices called winch) or cast.[43] The length of the discovered plate was 7.2 cm, width – 6-7.5 mm, and thickness – 1 mm. Due to the amount of lead required to make windows of this type this is a very small find, which in turn is the evidence that this expensive alloy was collected.[44] Leaded panes created a small web, and seen from a distance, a uniform "vibrating" surface.[45]

According to descriptions included in inventories, the castle buildings in Tykocin had windows with intact, complete panes, and only in a few cases there were some panes missing.[46] Documents, however, do not provide any information about the colour or quality of the glass used for glazing. Most probably the colour of glass panes in the façade seemed much darker from the outside than it actually was, whereas it was visible from the inside when seen "against the light".[47] Based on the finds retrieved from the ground it was greenish and clear. Due to the iridescence covering the surface of many panes, only their small number was analysed in terms of manufacturing technique. For this reason, it was not possible to draw far reaching conclusions. At the same time this points to the fact that the glass was not of the best quality and had standard flaws, primarily bubbles in the glass mass.

The shape of the finds in the assemblage is on the other hand the evidence of a variety of designed patterns of window panels, and there are several patterns that potentially may have been used. However, there are no grounds for determining whether each pattern was used separately or in combination with other panes, or only as decorative panels added to simple rectangular panes. In light of archaeological finds, it seems that the majority of windows had arched edges (Fig. 7).[48]

Numerous offcuts from edges of glass sheets included in the assemblage are a tangible evidence of glass panes being divided into smaller pieces at various angles to make the most of the available half-product and minimize the wasting of expensive material. Fragments with visible scratches are marks left by the planning of the distribution of individual elements and cutting them out from larger sheets of glass, often being failed attempts, which resulted in creating panes with uneven or chipped edges.

It is difficult to state the purpose of depositing that glass. Was it because, despite the fact that most fragments had defects, which rendered them immediately unusable for the purpose of the glazing carried out at that time, they were a valuable spare material that could be used for small repairs, such as replacing individual broken panes with small fragments salvaged from that assemblage? Or perhaps they were stored together to be traded as glass cullet bought and reused by glassworks. Or, being simply discarded leftovers, they became garbage straight away.

The first case would be a sign of the glazier's industriousness and reasonable use of the material entrusted to his care. However, during archaeological excavations carried out in that area research did not reveal any tangible evidence that would indicate that the location of the glass deposit was in any way sheltered (e.g. in a form of a timber building) or that the glass was stored inside some sort of container, which would support the hypothesis about their intentional deposition or protection against damage. It is also possible that the windowpanes under discussion were only glass cullet that was collected in that spot on purpose, with the intention of selling it or exchanging it for new items,[49] which again would indicate reasonable management of a still valuable material.[50] However, the fact that archaeologists discovered those finds means that the glass was never traded on and it remained unused waste. It is difficult to give reasons for such an outcome. The most probable explanation would be that there was no need to save glass material.

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[40] See Tajchman 1990, 33-34.

[41] Bis 2014, 387-389.

[42] See Darecka 2016, 47, Fig. 22. The author presents the summary concerning cross-sections of double-T bars used in Gdańsk from the 13th to the 18th century.

[43] Tajchman 1990, 19.

[44] Bis 2014, 395. During excavations in Tykocin castle archaeologists discovered in total a dozen or so such elements, as single finds or no more than four specimens in individual layers, see Bis 2014, 387, Fig. 3.

[45] Tajchman 1990, 35.

[46] In some cases, temporary measures were used; inserting other material instead of broken glass – wooden boards or brick (by building up a part of the window opening), Bis 2014, 385-390.

[47] Darecka 2010, 276.

[48] Compare examples of geometric glazing with lead cames from the territory of Poland from the 15th-18th century compiled by Jan Tajchman, most probably used in windows of Tykocin Castle in the second half of the 17th century, Tajchman 1990, Figs. 49A: a-b and 49B: g-i.

[49] See Wyrobisz 1968, 93.

[50] This would be justified particularly in the period to which the discussed window panes are dated (1660s). The District (*Starostwo*) and town of Tykocin were undergoing a period of economic decline until 1675 caused by the Swedish invasion (1655–60), which the authorities and the local community tried to overcome, Kochański 2010, 155.

The glazier would not have to keep flawed pieces and offcuts as spare material probably if he had a guaranteed constant access to new glass panes, e.g. if he was working on a large commission,[51] which in the case of Tykocin was the refurbishment of castle buildings destroyed during the siege in 1656.

Each of the above-mentioned options seem probable and leads to the conclusion that the question stated in the title of this paper will, at least for now, have to remain unanswered. A final argument to support one of those hypotheses would be a discovery of an assemblage of similar finds. Glass cullet made of post-medieval period windowpanes, collected at some point in a large quantity in one place and discovered during archaeological excavations, is known from, among other places, Puck and Warsaw. In both instances – like in the case of finds from Tykocin – those assemblages contained scraps of glass sheets created in the process of cutting and dividing larger sheets of glass into smaller panes and finished panes themselves. The assemblage discovered in the southern part of the town market in Puck, in a pit almost completely filled with such items, dating to the 18th century, contained 1,303 pieces. They were classified as glass from one context, which previously functioned in the same building situated close to the market square, in windows of different sizes. Those glass panes have marks of frames or cames from which they were removed.[52] On the other hand, finds from Warsaw were deposited in the strata of the town moat (constituting a unit of strata referred to as "B"), next to the north wall of the bridge, from the second half of the 17th century. There were 4927 pieces in total. All identified panes were unused. Research offered two possible explanations concerning circumstances in which this large and diverse backfill might have been created: firstly – that this was the entire scrap glass collected after the completion of one large refurbishment or construction project (including the glazing of windows), i.e. the rebuilding of the Kraków Town Gate carried out in 1662, following its destruction by the Swedish army six years earlier; secondly – that they were waste material from Warsaw glaziers' workshops disposed of in that spot when it was available during renovation work of the gate.[53] The dating and the characteristics of that assemblage in many ways correspond with finds from Tykocin Castle.

Another unclear issue is the provenance of the discussed glass. There is no information on that subject in the known accounts concerning the castle. In the period to which the glass is dated, i.e. in the second half of the 17th century, due to the economic crisis in Poland, generally domestic glass working activity collapsed and there were not many active glassworks.[54] Glass panes used for the glazing of windows in Tykocin potentially might have been manufactured by glassworks located in the territory of the Podlaskie Voivodship. Without any doubts window glass was produced in Orla and Kleszczele in the 1750s, as confirmed by written records. It must have been of a very good quality, if it was suitable for the glazing of windows in palaces of the Branicki family in Warsaw, Białystok (in 1758) and Choroszcz (in the years 1757-1758).[55] However, there is no similar data or more specific information about those glassworks with regard to the second half of the 17th century.[56] We also cannot rule out completely that glass used in Tykocin Castle was imported from a more distant location – for instance, from glassworks that functioned at that time in Pomerania or Lesser Poland, via Gdańsk or Warsaw,[57] if products of local manufacturers were not available or their quality was not good enough.

One of the indicators is the chemical composition of the discussed glass panes from Tykocin Castle. It may be compared with a small number of finds from this category from the territory of Poland that were to date subjects of physico-chemical analyses. These are mostly glass panes from Collegium Gostomianum Hill in Sandomierz (six specimens, most probably from the 17th-19th century),[58] from Plac Zamkowy in Warsaw (ten specimens, from the first and the second half of the 17th century)[59], from the Old Town in Warsaw (one item, from the 16th/17th-18th century)[60] and from the Gdańsk fortress Wisłoujście (two specimens, dated to the 17th and 17th-18th century).[61] It was established that in terms of the concentration of main components of glass results obtained for finds from Tykocin, Sandomierz and Warsaw are fairly similar, but they differ from the chemical composition of window glass from Wisłoujście.[62] Although the provenance of the

[51] Interpretation formulated for finds from Warsaw, Wilczak-Dąbrowska 2017, 79.

[52] Starski 2015, 154-156, Fig. 138.

[53] Wilczak-Dąbrowska 2017, 86-87.

[54] Kamieńska 1974, 83-86.

[55] Maroszek 1976, 180.

[56] We only have information about glaziers in Orla recorded in the years 1616-1655, numbering between one and four craftsmen, Maroszek 1976, 179.

[57] See Kamieńska 1974, 84-85, Map 4.

[58] Girdwoyń and Rubnikowicz 1996, 456, Table 1, inventory no. 702, 318, 1759, 2505.

[59] Wilczak-Dąbrowska 2017, 121, Tables 1-2.

[60] Ciepiela-Kubalska 2000, 238-239; see also Girdwoyń 1995, 88-89, Table 2, no. 5.

[61] Ryl and Szczepanowska 2015, 328, Table 11, inventory no 455, 458.

[62] They are primarily characterised by a much lower content of silica (Si) – 29.9% and 38.86%, calcium (Ca) – 3.9% and 4.8% and

above-mentioned artefacts was not determined, it was assumed that glass discovered in Sandomierz were products of glassworks that functioned in the south of Poland, perhaps in the area of Kielce,[63] and in Warsaw – were manufactured in the area of Holy Cross Mountains and were imported via Gdańsk or Kraków,[64] or were manufactured locally in Old Warsaw,[65] while the potential location of the smelting of glass discovered in the Gdańsk fortress was not stated.[66]

It is very probable that the craftsman who worked with glass panes from the discussed assemblage was a local glazier. Craftsmen practising this trade were active in Tykocin already in 1571[67] and in the 17th century,[68] and had a separate guild, as confirmed by written records. However, in the poll tax register from 1663[69] glaziers were not recorded among active tradesmen, whereas later sources – for the end of the 18th century – mention three glaziers' workshops operating in the town.[70] Names of the craftsmen were not provided.

Conclusion

Window glass, especially sheet glass, does not have macroscopic properties that are good chronological identifiers, as it does not change much over time. For this reason, such finds usually have a very broad dating. Compared with other glass finds, the assemblage from Tykocin Castle is primarily characterised by its specific nature – homogeneity due to the place of its discovery, dating, type and function.

The analysis of glass panes from Tykocin, despite their poor state of preservation, allowed for making some important observations, mainly with regard to the process of glazing and results of individual stages of such activity. Where possible, glass was analysed in terms of its formal, technical, technological and stylistic features. Design patterns used in Tykocin most probably varied and were made of glass panes of many shapes and sizes. The assemblage discussed in this paper provided an opportunity to examine glass that was processed and almost certainly manufactured around the same time, in the second half of the 17th century, most probably in the 1660s. The analysis of the assemblage of window glass from Tykocin may become a valuable contribution to our knowledge about this category of post-medieval period finds, which in the author's opinion requires further study.

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potassium (K) – 1.4% and 1.19%, while according to the analyses, they did not contain sodium (Na), or magnesium (Mg), Ryl and Szczepanowska 2015, 328, Table 11, inventory no. 455, 458.

[63] Girdwoyń and Rubnikowicz 1996, 455.

[64] Wilczak-Dąbrowska 2017, 112, 118.

[65] Ciepiela-Kubalska 2000, 241.

[66] See Ryl and Szczepanowska 2015.

[67] The inventory of the town from 1571 mentions one glazier, Mrówczyński 1983, 165, Table 1.

[68] Wyrobisz 1968, 196. Publications do not give precise information whether that data refers to the first or the second half of that century.

[69] Mrówczyński 1983, 169. The document also mentions three craftsmen without giving any information about the type of craft they represented. We do not know, however, whether there was a glazier among them.

[70] Maroszek 1976, 170, Table 25; Mrówczyński 1983, 170-171, Table 5.

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Streszczenie

Wyrzucone czy schowane? Szkło okienne z drugiej połowy XVII wieku zdeponowane na zamku w Tykocinie

Artykuł poświęcony jest szkłom okiennym znalezionym na terenie zamku w Tykocinie, zdeponowanym w północnej części założenia (Figs. 1-2), a pochodzącym zapewne z lat 60-tych XVII wieku. Zbiór ten wyróżnia się homogenicznością z uwagi na miejsce pozyskania, datowanie, rodzaj i funkcję. Tworzą go wyłącznie pozostałości szyb taflowych (1304 sztuki), o nie najlepszym stanie zachowania. Niewiele stwierdzono egzemplarzy całych, lub dla których możliwe było odtworzenie kształtu i wielkości (106, czyli 8% ogółu); dominowały mało charakterystyczne i rozdrobnione. Najwięcej stwierdzono szkieł średniej wielkości, czyli o powierzchni od 4,1 do 6 cm^2 (48,7%) (Tab. 1). Prawie 86% znalezisk uległo korozji o różnym stopniu nasilenia. Szkło nie było pierwszorzędne, lecz odznaczało się standardowymi wadami, głównie małymi pęcherzami powietrza widocznymi masie szklanej w dużej ilości, sporadycznie wtrąceniami ciał obcych, krystalicznych. Powierzchnia szyb z reguły była równa, lecz o zróżnicowanej grubości (1-5,5 mm). Szkło pierwotnie było przejrzyste, o zabarwieniu zielonkawym (Figs. 3-6). Dzięki analizom laboratoryjnym metodą EPMA sześciu ułamków szyb ustalono, że do ich produkcji użyto szkła wapniowo-potasowo-magnezowo-glinowo-krzemowego, niskoalkalicznego (wyniki w Tab. 2-3).

Stwierdzono, że w skład zbioru wchodzą liczne ścinki z krawędzią tafli szklanej (438 sztuk, 33% ogółu zabytków) (Fig. 3), świadczące o dzieleniu jej pod różnymi kątami, w celu maksymalnego wykorzystania materiału. Sporo odnotowano fragmentów z widocznymi rysami na powierzchni (45%) – śladami po rozmierzaniu poszczególnych elementów z tafli i ich wycinaniu, a także z krzywymi, nieregularnymi brzegami. To w większości wyroby nieudane bądź odpady powstałe podczas przygotowywania szyb, w wyniku niewłaściwego lub nieprzewidzianego odłamania. Na żadnym z egzemplarzy nie stwierdzono śladów po oprawie. To szyby wycięte, ale niezamontowane w ramy, które nie zostały użyte.

Na podstawie urozmaiconych kształtów zabytków zaproponowano kilka potencjalnych wzorów geometrycznych, które mogły tworzyć. Nie wiadomo, czy każdy zastosowano odrębnie, czy też w kombinacjach, lub jako ozdobne zwieńczenia oszkleń z szyb prostokątnych. Wydaje się, że przewagę miały okna z szybkami o łukowato uformowanych brzegach (Fig. 7). Część z nich miała retuszowane krawędzie (Fig. 4). Miały być zamontowane w ołowiane ramki.

Trudno rozstrzygnąć, dlaczego opisywane szkła okienne nie zostały wykorzystane jako rezerwa surowca lub nie przeznaczono ich do sprzedaży i ponownego przetopienia w hucie. Przypuszczalnie nie było konieczne oszczędzanie materiału, np. w sytuacji, gdy szklarz miał zapewniony stały dostęp do nowego surowca przy realizacji dużego zlecenia; takim w Tykocinie było szklenie okien w budynku zamkowym zrujnowanym podczas oblężenia w 1656 roku, w ramach prac remontowo-budowlanych prawdopodobnie prowadzonych w kolejnej dekadzie.