Supporting online material

Methodology and Terminology

All analyses were done in Qantir, and no analytical equipment beyond basic chemicals and an optical microscope were available. Therefore, working temperatures were estimated by the color and degree of vitrification of the ceramic, and by the degree of reaction between the ceramic and the lime layer. The appearance of local domestic pottery of the same fabric was used as a baseline for both color and degree of vitrification. All ceramic fragments were studied in accordance with the pottery system of the excavation and compared to the wide range of known New Kingdom vessel shapes; probably only three of these shapes were used in the context of glass production. According to (1), this fabric, also known as Nile E, is made from alluvial ferruginous Nile clay dominated by conspicuous fine and medium sized rounded sand grains within the paste. Other inclusions comprise some mica and sometimes chaff. This fabric is used for 90% of all silt vessels at Qantir, and it may be reasonably assumed that this is a local fabric.

The crucible and jar fragments used in the glass works had fabrics of varying red-purple-black shades, and a yellowish-green discoloration of the contact zone with the lime layer, which reflects varying degrees of firing and reaction between the fabric and the lime layer. This continuous range was artificially divided in four grades (2) to estimate working temperatures: a normal orange-red color of the fabric and no reaction zone between the fabric and the parting layer was termed ‘cold’; darker red to purple fabric color and either no or only a slight reaction zone, with lime substantially preserved, was termed ‘warm’; dark red fabric color and formation of a dark green glassy interface between the fabric and the lime was termed ‘hot’; a dark red to black and densely vitrified fabric and bloating of the interface was called ‘very hot’. An absolute temperature of about 900 °C is estimated as the lower limit of ‘hot’, based on the survival of calcite in the ‘warm’ samples. The temperature above which samples appear ‘very hot’ is estimated to be around 1050 to 1100 °C (3).
To identify primary glass making, raw or semi-finished glass has to be distinguished from refined and colored worked glass (4). Semi-finished glass is defined here as glass made directly from the raw materials, prior to refining and coloration. We used visual and basic chemical criteria to differentiate between potential raw materials, semi-finished and finished glass (5). Semi-finished glass has characteristic imperfections, including small-scale chemical heterogeneity of the glass phase and the occurrence at higher proportions than typical in worked glass of residual quartz, air bubbles, or crystalline phases formed during the batch melting. The glass phase itself is almost colorless, but appears white with both increasing proportions of inclusions and degree of corrosion (6).

To identify the quality of the glass residue, samples were removed from the ceramics and treated with hydrochloric acid to dissolve any post-depositional calcium carbonate and to separate the hydrated silica gel of the corroded glass from potential residual quartz particles. Sand grains and crushed quartz easily separated from the clouds of silica gel which were suspended in the liquid. The amount and nature of the crystalline particles were studied using the optical microscope and the result used to classify the sample as either semi-finished or finished glass; the latter rarely had any quartz inclusions at all.

Colored glass was identified by the presence of characteristic colorants or their corrosion products, and was inevitably free of significant amounts of inclusions. Glass originally colored red by copper oxide particles appears predominantly green fading into white when corroded; blue and purple glass corrodes white as well. This often made it impossible to determine the original glass color, or to distinguish between semi-finished glass low in imperfections and colored glass that is heavily corroded. Therefore, classification as semi-finished, red or blue glass was only done when diagnostic criteria were found for either of these categories, otherwise the glass was designated as ‘undetermined’.

References and Notes
2. This coarse classification served for a first assessment in the field, and requires refining and testing in the laboratory. This classification is not purely temperature-dependent, but does also reflect compositional variability of the materials involved, different reaction times, and oxygen and chlorine content of the gaseous phases. We believe, however, that the given temperature estimates are reasonable.

3. WES Turner (7) has shown experimentally that this fabric melts at around 1150 °C; the increased amount of CaO at the interface will have lowered this.

4. See (8, 9) for laboratory-based analytical approaches to identify raw glass making in an archaeological context. These, however, were impractical at Qantir.

5. We used a stereoscope with 6 to 50 times magnification and an attached digital camera, studying grain sizes, shapes and textures. Interpretation is based on comparison in appearance and structure to material produced during experimental and analytical work by (10). Hydrochloric acid was used to distinguish between calcium carbonate and silica-based phases. Quantitative chemical analyses would have been impossible under the conditions of field work, and almost certainly meaningless due to the heavily corroded nature of the glass.

6. Almost all glass finds from Qantir are completely corroded, due to the long-term chemical instability of soda-lime-silica glass under wet conditions. The leaching of alkali and earth alkali oxides from the glass results in the formation of a residual hydrated silica gel, which is opaque white.


