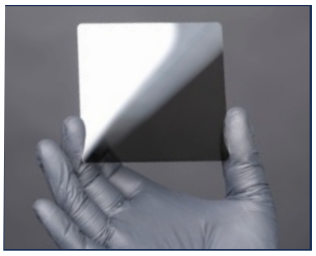
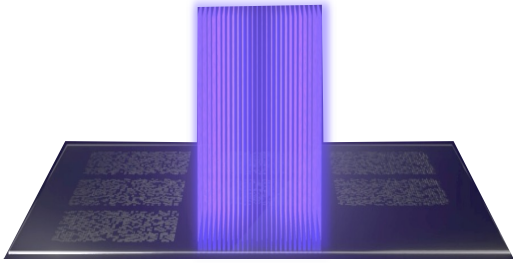
Cerabyte (www.cerabyte.com), founded in 2020, is developing Ceramic Nano Memory a data storage technology featuring a sputtered deposited extremely durable ceramic nano layer with a broad absorption spectrum, a “grey ceramic”, which allows ultra-fast write with threshold as low as 0.1 nJ per bit. The ceramic is deposited on both sides of a flexible ultra-thin planar substrate with only 100 µm thick foldable glass[1] or 10 µm thick ribbon glass[2] for potential tape development. These substrates and the coating a ceramic nano layers leverage existing display glass production capacities of today 350 million m^2 per year [3]. Thus the company expects to achieve media cost below $ 1 per TB by the end of this decade.

Cerabyte ceramic-on-glass sheets use ultra-thin glass as substrate material, which is cut to sheets of 9x9 cm, coated with a 10 nm thin dark ceramic nanolayer comprising only 50-100 atom layers, forming the novel data carrier.

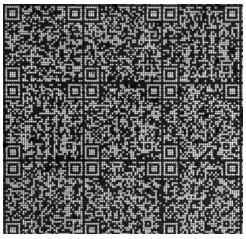
Squared glass carrier with dark ceramic nano coating



Laser beam matrix

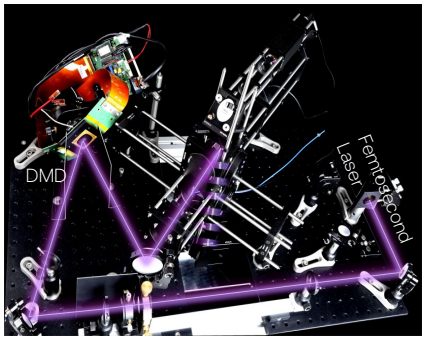


Matrix code permanently Inscribed in nano layer

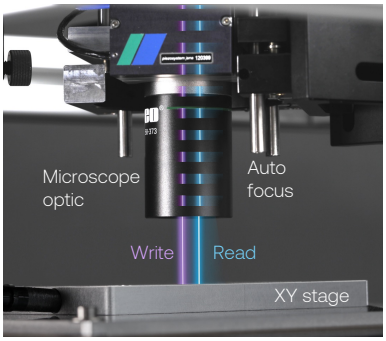


The writing process is using ultra-short laser pulses in combination with off the shelf digital mirror devices (DMD) which is commonly used in video projectors and head-up displays. The combination of the laser with a DMD generates a laser beam matrix which permanently ablates the ceramic nano-layer and writes up up to 2 million bits per pulse in parallel at high repetition-rates in the kHz range. This enables future writing speeds of 1+ GB/s with less than 1 W average power which is 3-4 times faster compared to LTO tape or HDD technology.

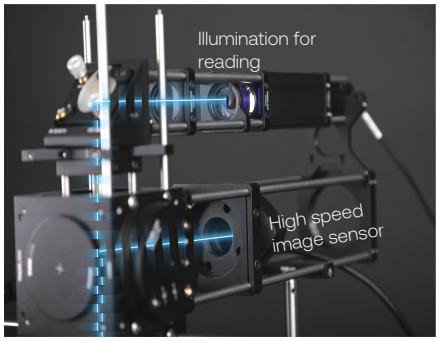
High-speed laser writing with DMD



Microscope optic for writing & reading



High-speed reading via image sensor



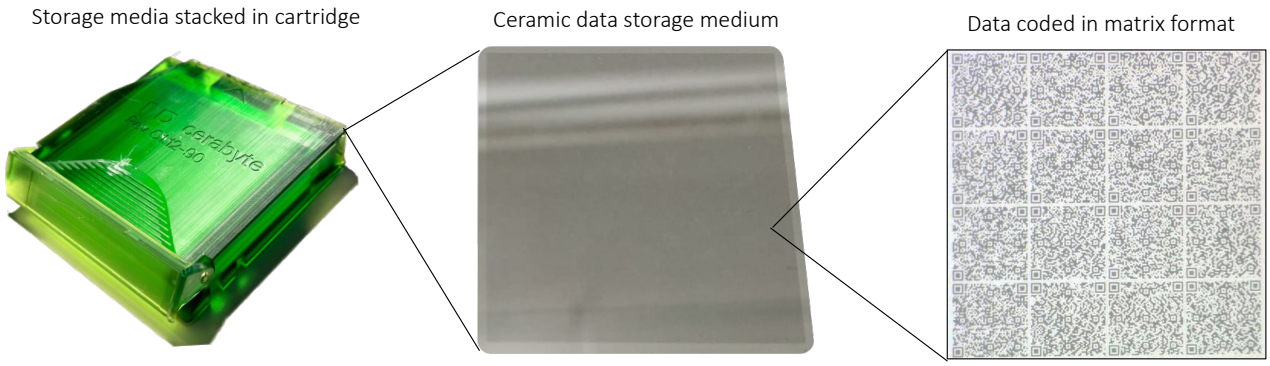
The reading process uses the same microscope optic, high-speed illumination and an ultra-fast high-resolution image sensor with 500+ frames per second. The decoding of these

[1] https://www.corning.com/worldwide/en/innovation/materials-science/glass/Foldable-Glass.html
[2] https://www.neg.co.jp/en/product/ep/glass-ribbon
[3] https://www.statista.com/statistics/1057441/display-panel-production-capacity-type/

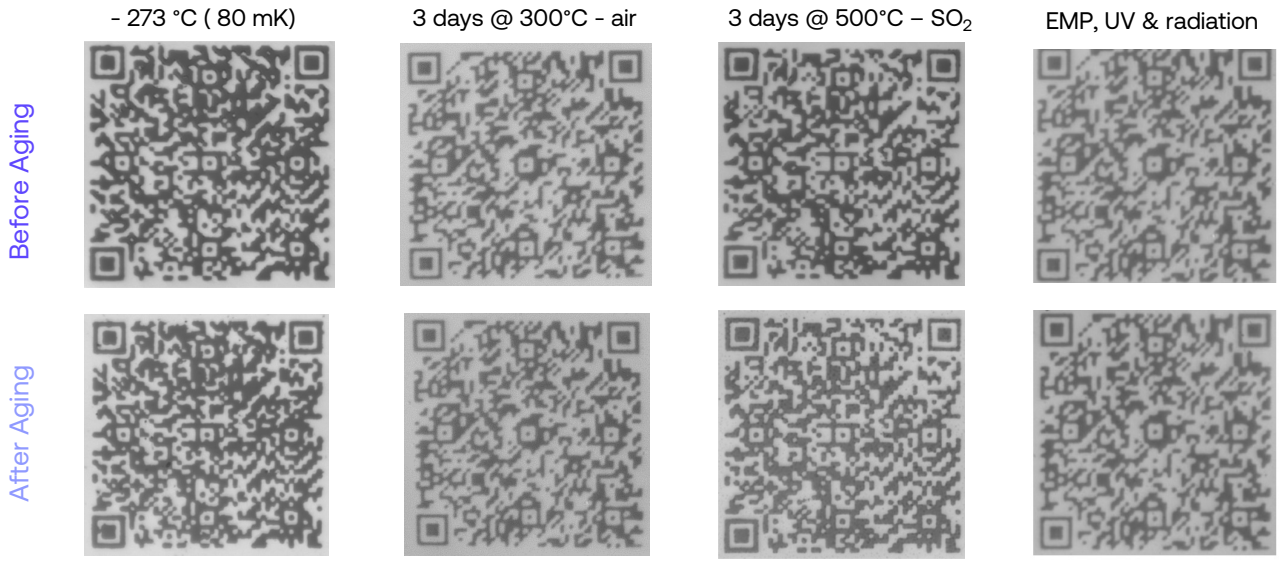
image data into digital data is than performed by parallel processing via FPGA (Field Programmable Gate Array) thus enabling reading speeds of 1+ GB/s, again outperforming HDDs by far. See video of the prototype system – Cerabyte from Vision to Reality

Both reading and writing are carried out across the substrate by scanning the microscope optics using high-speed XY stages kept in focus using a piezo driven auto focus system. This setup allows random access.

Multiple 9 cm by 9 cm Cerabyte sheets are stacked in individual cartridges to minimize volumetric storage volume. Cerabyte uses the external form factor of common magnetic tape cartridges, while media can be retrieved in a random-access regime achieving much shorter time to first byte compared to LTO tape.



Accelerated aging tests between -273 °C to 500 °C indicate potential storage lifetime in the millennia range. Furthermore, the data is not corrupted even when exposed to electromagnetic pluses, UV, or gamma rays.



Cerabyte employs a commercially available library unit utilizing a remote write architecture. The library will locate the and retrieve the cartridge, then unload and unstack the substrates for positioning the addressed substrate in the optical unit.

The Cerabyte prototype system with a single write & read head unit achieves 5 MB/s write/read speeds. The first demo system for archiving customers is scheduled to be available for remote testing in 2024 with 100 MB/s write/read speeds and a capacity of 1 PB/rack with up to 10 robotic library racks. In 2025 a 20 rack system for cloud data centers will be launched with 1 GB/s write/read speeds and a capacity of 10 PB/rack, which increase over time and will achieve capacities attractive for hyperscalers by end of the decade.

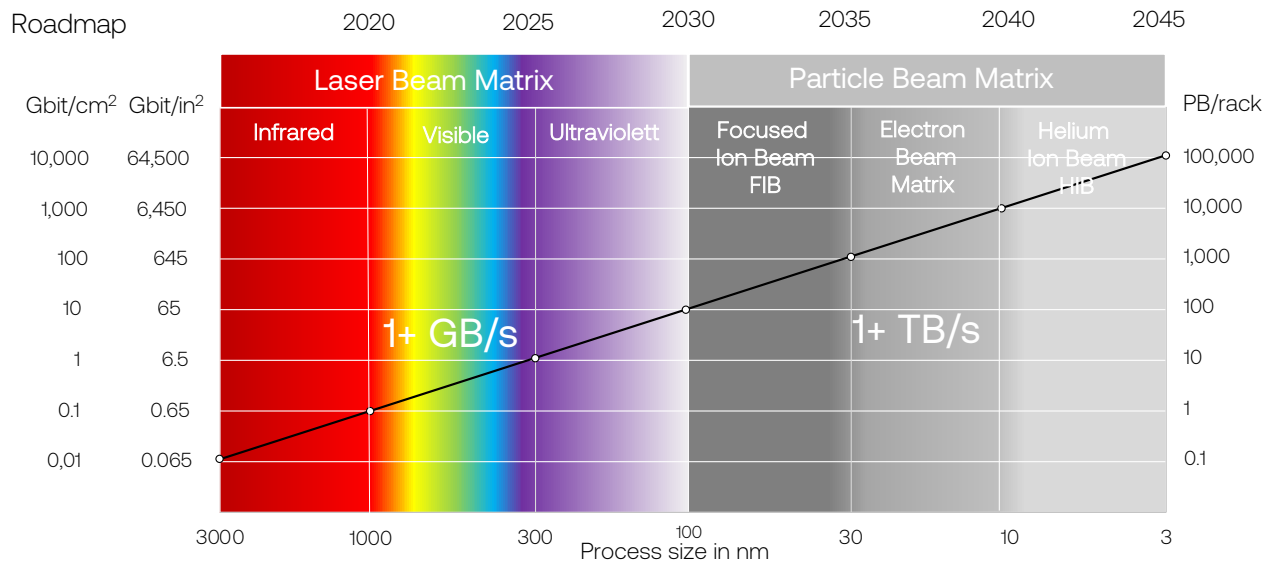
1 PB/rack
100 MB/s
<90 sec to first byte

5 PB/rack
500 MB/s
<30 sec to first byte

10-30 PB/rack
1+ GB/s
<15 sec to first byte

60-100 PB/rack
2+ GB/s
<10 sec to first byte

The visionary roadmap foresees the usage of high-speed particle beam matrix beyond 2030, which will significantly decrease the nano-layer size reaching storage capacities in the exa-byte range while boosting writing and reading speeds significantly.



The roadmap until 2030 and beyond is strengthened by a comprehensive intellectual property (IP) portfolio, comprising an extensive collection of international patents and patent applications covering storage media, writing/reading devices and high-density matrix formats underpin the company's commitment to technological leadership and innovation of cold data storage. The patent portfolio covers 80 % of global GDP, 85% of global data storage infrastructure, 67% of smartphone penetration and 49% of global population.