

X-Ray Optical Memory (X-ROM)

by Hakob (Jacob) P. BEZIRGANYAN,^{a)} R & D Director, Ph.D. and
Siranush E. BEZIRGANYAN,^{a)} Leading Research Scientist, Ph.D.

^{a)} X-ROM, Inc. & V Group, Inc., King County, WA, USA

New Global Economy - is the Low-Carbon Economy. Most amount of the carbon on Earth is in the plants, coal, and oil. Plants absorb the carbon from atmosphere and store it in the wood fiber. In the Low-Carbon Economy, forestry operations will be focused on low-impact practices and re-growth. Forest managers will make sure that they do not disturb soil based carbon reserves too much. Specialized tree farms will be the main source of material for many products. Quick maturing tree varieties will be grown on short rotations in order to maximize output.

One of the pathways towards the Low-Carbon and Forestry Economies could be a Paper-Less Economy, because paper is typically made from the wood fiber, and its consumption puts substantial pressure on the world's forest ecosystems. It is evident that the ultra-high density digital storage of data and documents in electronic form would lead to a decline in paper consumption. Hence the incessant interest to various techniques and technologies developed for the creation and storage of the huge volumes of digital information.

Forthcoming devices with the increasing digital data storage capacities require a read-out system operating on an angstrom wavelength radiation i.e. on the x-ray wavelength. Data storage media are particularly produced on the base of the semiconductor nanostructured crystalline materials.

- We have worked on and currently are promoting **X-Ray Optical Memory** (or "**X-ROM**") - the next-generation ultra-high definition hard x-ray optical storage device with the digital data density of about 10 Tbits per square inch for each storage layer of developed "**X-ROM disc**".
- Proposed "**X-ROM**" is the radically new x-ray-based optical data storage technology. Digital data reading procedure from such ultrahigh-density x-ray optical data storage media is performed via grazing-angle incident x-ray micro beam. Proposed x-ray-based optical data storage system detects data by measuring the changes in x-ray micro beam intensity reflected from the various surface points of data storage media. Grazing-angle incident x-ray configuration allows the simultaneous handling of digital data from very large area, which is limited only by the hard x-ray receiving surface of the charge coupled device (or "**CCD camera**"), and, consequently, the data read-out speed is much faster, in principle, than the data read-out speed of modern optical data read-out systems.

BENEFICIARIES FROM THE X-ROM IMPLEMENTATION

The volume of data is growing exponentially around the world, so the **X-ROM** implementation would be a temporary success in the "combat" against nowadays information explosion. **X-ROM** is mainly designed for the following target customers:

- Any organization that has the need to store and keep available digital information over many years such as Deposit Libraries, National Archives, Governmental Institutions, Pharmaceuticals, Banks and Insurance Companies.

- Today the topical problem is to bring the concept of “distance learning” technology beyond the classroom and the auditorium to public settings and more personally to the home i.e. much more access to better education (see e.g. [1]).
- Much easier re-use of the archived information to create new or adjusted (digital) information. Commercial interests can become very large, e.g. when a building or an airplane needs to be modified and the digital “blue print” can’t be viewed anymore, because the technology, with which it was made, has become obsolete. In such cases it might cost a person-year or more to re-create the original drawings. Sometimes, long term digital preservation is a necessity; e.g. for compliance reasons.

Thus, **X-ROM** is designed for any type of long-term digital information archiving system (**DIAS**).

BRIEF REVIEW OF THE X-ROM THEORY AND NANOTECHNOLOGY

The study of wave propagation in one-dimensional periodic media was pioneered by G. Floquet in 1883 [2]. This theory was extended for three-dimensional periodic media by F. Bloch in 1928 [3]. Bloch proved that waves in such a medium can propagate without scattering, their behaviour governed by a periodic envelope function multiplied by a plane wave. The same technique can be applied to electromagnetism by considering Maxwell’s equations as an eigenvalues and eigenfunctions problem in analogue with Schrödinger’s equation (e.g. see [4, 5]). Using such approach, we are treating the dynamical diffraction of x-rays by a set of diffracting lattice planes (hkl) of perfect crystal as the superposition of x-ray “Bloch waves” in a medium with harmonically varying dielectric susceptibility (polarizability) $\chi_{hkl}(\mathbf{r})$. Therefore, the problem of x-ray wave field propagation through an arbitrary set of diffracting lattice planes of periodic structure with the symmetry centre can be brought mathematically to an analogous problem of the solution of stationary Schrödinger equation with cosine-like coefficient [4].

Semiconductor nanostructure devices e.g. could operate using the grazing-angle incidence x-ray backscattering diffraction (**GIXB**) technique [4, 5], which takes place in the conditions of specular vacuum wave suppression phenomenon since in the conditions of the reflected wave suppression mode the specular wave (contrary to other existing X-ray diffraction methods) practically carries the information only about the non-diffracting subsurface reflectors [6-8]. The **GIXB** is a high-resolution and non-destructive technique, which is possible to realize only if the Bragg angle is close to 90° . **GIXB** configuration first was considered in 1985 (see English version [4, 5] of origin papers, which concern **GIXB** by single crystals and very thin crystalline films).

Another mechanism of the digital information read-out procedure [9] utilizes the grazing-angle incidence x-ray reflection (**GIX**) technique. These two mechanisms of the digital information read-out procedure enable, in principle, the fabrication and exploitation of two-layer **X-ROM**. Angle of incidence of the x-ray micro beam is different for each storage layer of the proposed two-layer **X-ROM** [10].

The resolution of digital data read-out device could be increased by the grazing-angle incidence hard-x-ray nanoscope (or “**GIXN**”) proposed in [11], which is an essential detail of the ultra-high density digital data read-out device. Detailed evaluation of storage data-layer’s effective (optimal) thickness best fitted for a digital data read-out procedure is presented in [12, 13].

Proposed ultra-high density data storage **X-ROM** nanotechnology has been presented in various International Scientific Conferences [12-24].

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