DNA memory for mass storage of digital data

R. Zadegan and W. Hughes†
†Boise State University, USA

With the current growth of digital media, projected refined silicon supply for the year 2040 cannot satisfy the semiconductor industry needs, and this results in a big shortage of memory materials. Our calculations suggest that worldwide data storage needs will exceed 3×10^{24} bits by 2040 (~2 yottabyte or two billiard gigabytes), whereas with the current rate of silicon-based memory growth, only ~2% of that capacity will be achieved. Scaling and energetics of information storage materials are the major concerns of semiconductor industry. Therefore finding alternative sources for information storage is critical. DNA molecules are known to carry information of life by encoding/decoding the life pathways. Nucleic acids are plentiful, recyclable, dense, and their operation energy is very low and thus the DNA memory is a cost effective emerging technology. According to our calculations only 1 kilogram of DNA satisfies the storage needs of year 2040. If stored in silicon based memory, such amount of information should be stored in about 5 billion kilograms of silicon. One other advantage of DNA memory is the long retention time of information comparing to current memory materials. Current digital information storage media have short information retention time of less than a century. DNA is a material that encodes information with a quaternary code of A,T,C,G. According to our calculations DNA Memory has volumetric density of 10^3 times greater and energy of operation 10^7 times less than flash memory that is the industry standard. Reading and writing of arbitrary digital formats is being enabled by the rapid progress in DNA synthesis and sequencing.[1, 2] This study is in pursuit of non-biological and nonvolatile DNA memory applications.

References

1. Church, G.M., Y. Gao, and S. Kosuri, Next-generation digital information storage in DNA. Science, 2012. 337(6102): p. 1628.
2. Goldman, N., P. Bertone, S. Chen, C. Dessimoz, E.M. LeProust, B. Sipos, and E. Birney, Towards practical, high-capacity, low-maintenance information storage in synthesized DNA. Nature, 2013. 494(7435): p. 77-80.