

FEL THz Irradiation Approach for the Biochip Production Standardization

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Abstract— The terahertz emission was applied to the development of the technology for the biochip production standardization. The approach is based on the method of soft nondestructive ablation developed by authors, which means the transfer of target DNA to aerosol phase from solid substrate of a biochip under action of the terahertz emission.

I. INTRODUCTION AND BACKGROUND

THE complementary pairings of hydrogen bonds of DNA nucleotides are the base of biochip applications. The covalent bonds define chemical structure of the molecules. The hydrogen bonds define secondary and high order structures of the biomolecules. The Van der Waals bonds define different interactions between molecules. THz quant energy is corresponded to approximately 0.01 eV. Low energy quantum retains the covalent bonds in molecules intact, the ablated molecules conserve native structure. On this base were developed methods of protein and nucleic acid soft nondestructive ablation for biomacromolecules transfer from solid surface into aerosol phase under action of the terahertz emission.

The terahertz emission of the Budker INP Free electron laser was applied to the development of the technology for the biochip production standardization. Parameters of terahertz emission are presented in the fig.1.

Microarrays are used to study gene expression in pancreas cells¹. DNA microarrays from 3 leading suppliers: Affymetrix, Agilent, and Amersham demonstrated wildly discordant results. Out of 185 genes common to all three arrays, the expression pattern of only 4 genes agreed with one another. In other words, the noise level could be as high as 98% in 2003. In the 2007 the noise level was substantially reduced by different methods of pretreatment and statistic, but the need for consistent, reproducible results across platforms is remained open.

II. RESULTS

To develop the method of biochips production standardization the molecular design of model biochip oligonucleotides and polymerase chain reaction analysis of ablation product were developed. The prototype of two different biochips on high resistance silicon substrate were manufactured and requirements to the coating and immobilization of oligonucleotide probes on silicon substrate were developed. Then the method² of soft nondestructive ablation of biological macromolecules under terahertz irradiation was applied to technology for the direct analysis of the target DNA. Target DNA was hybridized to the DNA-

probe by hydrogen bonds with probe DNA. By the action of terahertz emission hydrogen bonds were disrupted and target DNA was transferred into aerosol phase. The target DNA was collected to the filter for subsequent analysis.

Firstly, ablated target DNA was amplified by Polymerase Chain Reaction. Polymerase Chain Reaction product was identified by electrophoretic analysis. The electrophoretic analysis proved identity of initial and ablated DNAs.

Secondary, the following sequence analysis proved the sequence identity of initial and ablated DNAs.

Figures:

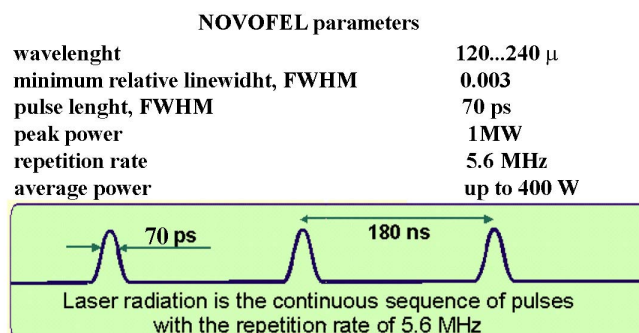


Figure 1. NovoFEL parameters

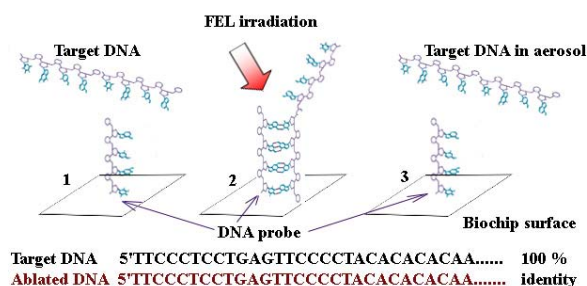


Figure 2. Art view of model biochip investigation.

REFERENCES

- [1] E. Marshall, "Getting the Noise Out of Gene Arrays" *Science*, 2004, V. 306, 22, pp.630-631.
- [2] A.K. Petrov, A.S. Kozlov, S.B. Malyshev, M.B. Taraban, V.M. Popik, M.A. Scheglov, T.N. Goriachkovskaya, S.E. Peltek, "Nondestructive transfer of complex molecular systems of various origins into aerosol phase by means of submillimeter irradiation of free-electron laser (FEL) of the Siberian center for photochemical research" *Nuclear Instruments and Methods in Physics Research A*, 2007, V. 575, No 1/2, pp. 68-71.