Introscopy of solids at Novosibirsk terahertz free electron laser

V. S. Cherkassky, B. A. Knyazev,. G. M. Ivanov, L. A. Lukyanchikov, A. N. Matveenko, L. A. Merzhievsky, G. N. Kulipanov, N. A. Vinokurov

Novosibirsk State University, Pirogova St., 2, 630090 Novosibirsk, Russia
Budker Institute of Nuclear Physics, SB RAS, Prospect Lavrentieva, 11, 630090 Novosibirsk, Russia
Institute of Hydrodynamics, SB RAS, 630090 Novosibirsk, prospect Lavrentieva, 15, Russia
B.A.Knyazev@inp.nsk.su

***Abstract*- High-power Novosibirsk free electron laser, generating coherent monochromatic tunable radiation within the spectral range from 120 to 240 micrometers, is used for the shadwography of semi-transparent objects. Toepler and holography systems, which are under construction, will enable spectrally-selective imaging at the laser beam diameter of about 10 cm.**

I. Introduction

High power terahertz free electron laser (FEL) opens opportunity for spectrally-selective introscopy of the objects which are opaque for visible radiation and practically absolutely transparent for x-rays. Detection of illegal chemicals and biological substances, study of tension and damage of solids, holography of phase objects, control of production quality are the fields where terahertz introscopy can be applied.

II. Shadowgraphy with FEL Radiation

Novosibirsk free electron laser beam, which maximum average power reaches the magnitude of 400 W, has the beam diameter of about 10 cm. Using the visualization systems, described in [2], we have demonstrated feasibility of the introscopy with the repetition rate of 25 frames per second. Areal distributions of terahertz radiation absorption, $(I_0–I)/I$, where I_0 and I are the local values of incident radiation intensity and intensity after passing through a sample, respectively, are presented for several samples in Fig. 1.

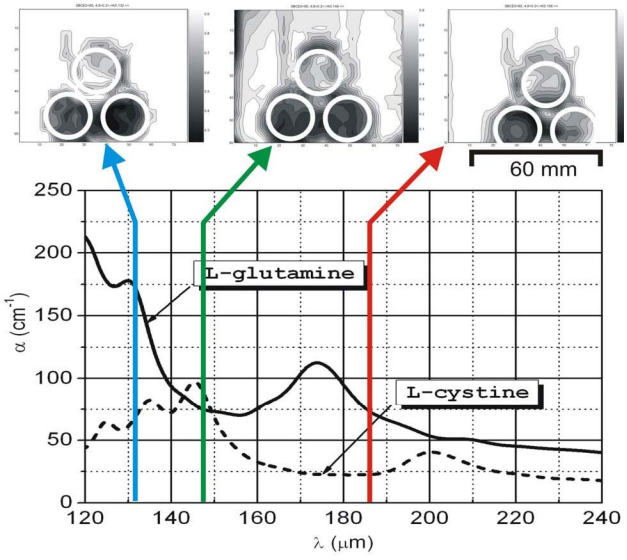

Figure 1. Absorption of three 20-mm diameter tablets pressed from Teflon powder at three wavelength. At the top – pure Teflon, at the bottom – the tablets containing L-cystine (left) and L-glutamine. Their absorption coefficients vs. wavelength are given in the plot.

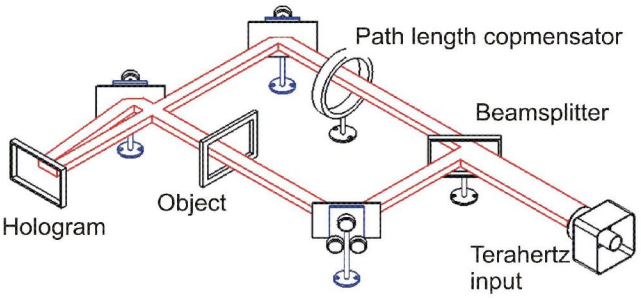

Figure 2. Design of a holography system intended for use with terahertz FEL, whose coherence length is about 20 mm.

III. Schlieren and Holography Systems

Experiments on the shadowgraphy have demonstrated a very strong effect of diffraction in the terahertz region. To obviate this obstacle we are constructing a holographic system (Fig. 2) and a Toepler (image filtering) system with FEL as a source. Holograms will be recorded with one of the imaging systems [2] and digitally reconstructed. It enables, in particular, to realize a "two-expose holography".

Acknowledgments

This work is partially supported by the Integration grant #174/6 from Siberian Branch of Russian Academy of Science and by the grant RNP.2.1.1.3846 from Russian Ministry of Education and Science.

References

[1] V.P. Bolotin, N.A. Vinokurov, D.A. Kayran et al., "Status of the Novosibirsk terahertz FEL", *Nuclear Instruments and Methods in Physics Research,* vol. A543, pp. 81-85, 2005.

[2] V.S. Cherkassky, B.A. Knyazev, V.V. Kubarev et al., "High Speed Terahertz Imaging Using Thermosensitive Elements", *These Proceedings.*