# Half-Cycle Terahertz Pulse Generation in Intense Laser Interaction with Nanostructured Target

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Half-cycle terahertz pulse generation in a super-intense laser radiation interaction with a nanostructured target consisting of nanowires or nano foil stripes is studied. During prop¬agation of a relativistic laser pulse along a nanowire (longitudinal interaction), dense high-charge bunches of electrons are forced out of the target and accelerated in the laser field, generating high-power electromagnetic radiation with various spectral composition, including terahertz and infrared ranges [1]. For a relatively long laser pulse (tens or hundreds of femtoseconds) with a smooth shape, nanowire electrons are displaced from the target by each laser half cycle. In this case, the low-frequency part of the generated radiation can have a unipolar half-cycle shape with characteristics determined by the laser and target parameters. Such a shape of radiation allows adding coherently emission from different target nanowires inside the laser spot. Due to nanometer-scale transverse dimensions of the nanowire, laser field amplitude decreases only in its vicinity after the interaction. Then a spatially rich nanostructured target formed by parallel nanowires, each using its own part of the laser front, can produce stronger radiation. Also, for a relatively long laser pulse, its amplitude decreases when interacting with the nanowire only for the first few periods. In this case, consecutive interaction of a laser pulse with nanowires can be used, and the nanostructured target can be formed from the consecutive nanowires. Moreover, using several regularly located nanowires (or nano foil stripes), one can engineer the shape of the generated radiation pulse or even produce a train of half-cycle terahertz or infrared pulses with the controlled delay between them.

The efficiency for generating low-frequency radiation during laser pulse propagation along a nanowire can be significantly higher than in other geometries of interaction. In longitudinal interaction, the displaced electrons and the laser pulse propagate in the same direction for some time, which increases the duration of their interaction, while the field amplitude decreases weakly because of a small cross-section of a nanowire. Besides, using multiple parallel nanowires in the nanostructured target irradiated by a single laser pulse or using the laser pulse repeatedly until its full depletion through interaction with consecutive nanowires in the nanostructured target increases efficiency even more. So the main advantages of using nanostructured targets are the possibility to engineer the shape of the radiation pulse and to increase the efficiency for terahertz pulse generation.

Using numerical 2D simulation, characteristics of half-cycle infrared and terahertz radiation pulses are found for nanostructured targets. The conversion efficiency of the laser pulse energy into the energy of generated radiation is estimated. It is shown that the conversion efficiency of the nanostructured target can be several times higher than those of the single nanowire.

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**References**

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