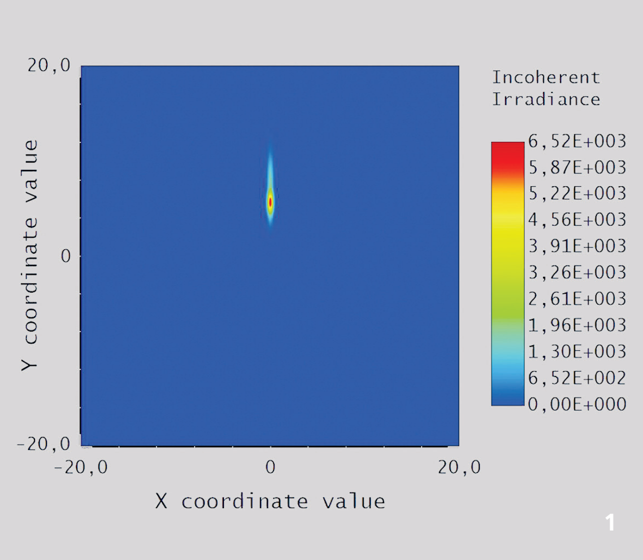

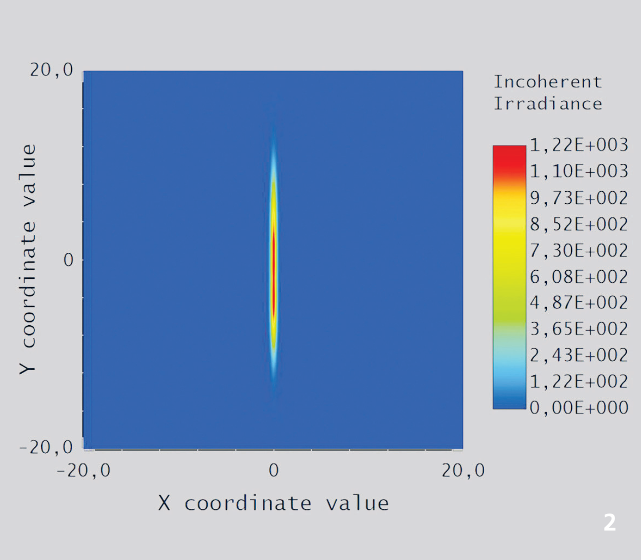

GAS DISCHARGE PLASMA AS MEDIUM FOR XUV LASER

Task

Dense, hot, and cylindrical plasmas with a high aspect ratio of length to diameter are of interest as a medium for enhanced spontaneous emission (ASE) or for brilliance optimization in the axial viewing direction. Elsewhere in the past, argon-based gas discharge plasmas have been successfully demonstrated with ASE at 46.5 nm. In this case, electron densities of 10^{18} - 10^{19} per cm^3 at temperatures in the range of 50 - 200 eV must be achieved. Fraunhofer ILT is working on discharge concepts in which such plasmas can be generated in the future with a higher repetition rate in the range of several kilohertz, with higher average radiation power and long-term stability.

Method

To generate plasmas with longer axial expansion of several centimeters, Fraunhofer has modified the electrode system using an existing gas discharge concept. Systems based on this concept are in commercial use in many places today. The approach the institute has chosen provides the technical pre-requisites for scaling ASE-capable plasmas to a higher emission output and longer service life.

Results

The typical length of the plasma is approximately 3 - 4 mm for a state-of-the-art electrode geometry (see Figure 1). The diameter is between 300 and 500 µm in the axial direction of observation. In a first step, the length could be increased to about 20 - 30 mm with a modified electrode system. Figure 2 shows the reconstructed intensity distribution of an argon plasma. From the emission spectra, electron density and temperature can be estimated to be about 10^{18} per cm^3 and 50 eV, which means that the ASE conditions can be maintained after further optimization steps.

Applications

Highly brilliant, incoherent and partially coherent (ASE) radiation plasmas in the spectral range of the extreme ultraviolet (XUV) can be applied in microscopy or structuring on the nanometer scale, for example, in mask inspection in future semiconductor production.

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Intensity distribution of the EUV emission:

1 *... in the electrode system for geometry optimized for short plasmas (edge length 40 mm).*

2 *... in the electrode system for a longer discharge channel (edge length 40 mm).*

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