Optimization of a cluster-based laser–plasma source of Kr K_α radiation for X-ray diffraction

Tausenev A.A.[1,@], **Semenov T.A.**[1], **Scheglov P.A.**[1], **Chaschin M.V.**[1] **and Nazarov M.M.**[1]

[1] National Research Center "Kurchatov Institute, Kurchatov Square 1, Moscow, 123182, Russia

[@] tausenev94@gmail.com

Cluster targets irradiated with a fs laser make it possible to generate bright pulsed (≈2 ps) characteristic-radiation sources [1] that can be used for pump–probe experiments with high temporal resolution. Key features of such targets include stability, the absence of contamination, and the ease of controlling their parameters and composition. In this work, to achieve a higher krypton K_α yield, the cluster diameters (50-60 nm) and concentration ($\sim 10^{12}$ cm^{-3}) in the jet were optimized by adjusting the pressure (30-40 bar). The jet was irradiated with femtosecond (30 fs) 5 TW laser pulses focused to 5×10^{18} W/cm^2. As a result, for ∼60 nm krypton clusters a K_α photon yield of 3×10^8 photons/($4\pi \times$pulse) was achieved. Changing the atomic composition of the clusters to argon enabled K_α (3 keV) generation with a yield of 2.5×10^8 photons/($4\pi \times$pulse). The Bragg diffraction peak of this K_α line from an Si(111) crystal was measured. Estimates of the parameters of an X-ray pump–probe experiment were made, and the optimal characteristics of the developed source for this experiment were determined.

[1] Shcheglov P, Nazarov M, Semenov T, Tausenev A, Chashchin M, Lazarev A and Gordienko V 2024 *Bull. Lebedev Physics Institute* **51**(7) S564–S571