X-Ray Laser in an Ablative Capillary Discharge Driven by an m=0 Instability

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The development of EUV and soft-X ray lasers made great progress during the last decade. In most cases powerful primary lasers in the UV-, visible and near-infrared spectral regions are employed to produce the dense hot plasmas needed as active media for the lasers. Widely spread applications require small table-top systems and here capillary discharges offer an alternative approach and are being studied by several groups. By selecting properly the transient discharge conditions, collisional excitation or three-body recombination are the effective mechanisms to achieve population inversion. At the Ruhr-University a different approach is pursued where charge exchange between different ions in colliding plasmas is utilized. The plasmas are produced in a small ablative capillary discharge made of polyacetal. In the second half cycle an m=0 instability develops and results in hot plasmas in the neck regions which stream into the cold plasma outside and create overpopulation of the n=3 level of hydrogenic carbon leading to lasing on the Balmer-alpha line at 18.22 nm. A waved structure of the inner capillary wall induces reliably the instability and pinhole pictures give the clue why not all materials are useful. Double pass experiments using a multilayer mirror give an effective gain-length product of GL=4.3 for a 3 cm long capillary and a life-time of the inversion layers of 400 ps.