on proton ring translation in a magnetized plasma by Schamiloglu et al.

Plasma Chemistry

Several of the papers in this session were relevant to plasma processing. One paper discussed modeling of electron dynamics in a parallel plate reactor. A second paper discussed an innovative plasma source for pulse etching materials. Process engineering was the subject of a third paper in which wafer temperature was used to control the sidewall angle of a trench etch in silicon. Finally, a diagnostic technique was described in which Fourier transform mass spectroscopy was used to analyze the properties of argon ions. The remaining two papers were not plasma processing related: one concerned the microwave discharge excitation of XeO excimers and the other discussed the breakdown of organic molecules in a plasma environment.

Plasma Focus

Since the plasma focus was discovered in the early 1960s, this subtle phenomenon has been persistently studied to understand fundamental underlying physics. It has evolved into intense sources of charged particles, neutrons, and radiation. The papers in this session represent an update of the knowledge gathered about the plasma focus phenomenon. The topics include dynamics of the current sheath, high neutron yield, measurements and production of charged-particle beams, a spectroscopic investigation of plasma, and a fusion reaction study.

Ultrafast *Z*-Pinches

This poster session included ten papers, which can be divided into two groups. The first group dealt with the study of *Z*-pinches in extruded deuterium fibers. The second group dealt with the study of gas-embedded *Z*-pinches as X-ray sources. NRL and LANL discussed the dynamics of deuterium fiber *Z*-pinches driven by different current waveforms. Pease-Braginskii equilibria, radiative collapse, and the intriguing possibility of such systems for a fusion system were explored. In a related review talk, Haines (Imperial College) also described the physics of radiative collapse in *Z*-pinches.

Gas-embedded *Z*-pinches were described by groups from Cornell University, SNL, and Imperial College. The SNL papers dealt with the sensitivity of implosion dynamics to initial conditions, as well as the efficacy of gas puff-on-coaxial, thin-shelled targets for X-ray production. The Imperial College paper presented detailed insights into hot spot formation in gas puff *Z*-pinches.

X-Ray Laser

The effort to develop new X-ray lasing schemes and to push existing schemes to shorter wavelengths has continued with both optical-laser-driven and pulsed-power-driven X-ray laser experiments.

Recent X-ray laser experiments that use optical lasers as the pump source have shown progress toward soft X-ray laser wavelengths in the water window ($<$44 Å). LLNL personnel, in collaboration with the Centre d'Etudes de Lemeil, have studied the variation of gain as a function of pump laser wavelength (1.06, 0.53, and 0.35 μm) and intensity for both neon- and nickel-like recombination schemes. Gains near 5 cm have been measured in neon-like systems and near 1 cm in nickel-like systems. They have also begun looking at hydrogen- and lithium-like recombination schemes as alternatives to reach shorter wavelengths. Work on the lithium-like recombination scheme include experiments at the Laboratoire de Spectroscopie Atomique et Ionique in Orsay, France, where recent results indicate gains of 0.5/cm in lithium-like aluminum plasmas. Work at LLNL to model the soft X-ray optical effects in exploding foil X-ray lasers has been successful in reproducing the temporal and spatial X-ray laser beam patterns that are observed experimentally.

The pulsed-power-driver X-ray laser programs continue to work on X-ray pump source development and plasma generation. Soft X-ray laser schemes presently being emphasized include the sodium/neon line-matched, lithium-like aluminum and hydrogen-like neon recombination, and photoionization pumped neon-like recombination schemes. Although these pulsed-power accelerators have shown that they efficiently generate interesting plasmas as well as intense X-ray fluxes, no soft X-ray lasing scheme has been successfully demonstrated.

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SUMMARY OF THE U.S./JAPAN WORKSHOP ON PLASMA-BASED 14-MeV NEUTRON SOURCES, OSAKA, JAPAN, JUNE 7–10, 1988

The first U.S./Japan workshop on plasma-based 14-MeV neutron sources was held at Osaka University, Osaka, Japan, June 7–10, 1988. This workshop was organized to accelerate development of concepts for a plasma-based fusion materials irradiation facility (FMIF). Existing fission reactors and low-intensity deuterium-tritium (D-T) neutron sources are presently used in the early stages of fusion materials development. However, final selection, acquisition of engineering data, and qualification of low-activation, long-lived materials for construction of fusion reactors will require life tests in a facility that provides the appropriate D-T neutron energy spectrum at an accelerated rate. In recognition of this need, the U.S. Magnetic Fusion Program Plan specifies initial operation of materials test facilities in the mid-1990s. To provide accelerated testing, the neutron flux at the sample position should be at least an order of magnitude greater than that expected at the fusion reactor first wall. Fortunately, the volume of materials samples can be modest, possibly allowing construction of a compact facility at a small fraction of the cost of a reactor or even that of the next proposed plasma containment device.

Requirements of neutron sources were discussed in the first technical session by a panel of U.S. and Japanese materials scientists. They pointed out that an FMIF should provide sufficient neutron fluence for end-of-life (EOL) materials irradiations in ~1 yr. Here, an EOL irradiation is taken to be 100 to 200 displacements per atom, which approximately corresponds to a 10 MW·yr/m^2 or greater 14-MeV neutron fluence. It was also pointed out that the FMIF must provide temperature and environmental control for material samples, as well as providing an *in situ* test capability.

The six following plasma-based concepts were compared with an accelerator based D^+-Li design: a symmetric tandem mirror heated and stabilized by radio-frequency power, injection of neutral deuterium beams into a tritium plasma target, a reversed-field pinch, a two-component tokamak, a dense Z-pinch, and a dense plasma focus. A preliminary comparison of these concepts was made on the basis of their materials test capabilities (flux, volume, neutron energy spectrum, pulsed versus continuous waves, etc.), required development costs and schedule, construction costs and schedule, operating costs, power requirements, tritium consumption, tritium inventory, and decommissioning requirements. At this time, the data base for such a comparison is incomplete and much of the existing data is preliminary in nature. In general, designs based on conventional fusion reactor concepts were more costly and provided lower neutron wall loads, but also provided large test volumes suitable for development of nuclear components, such as tritium breeding and power conversion blankets.

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