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NASA TECH BRIEF

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High-Power CW Laser Using Hydrogen-Fluorine Reaction

The problem:

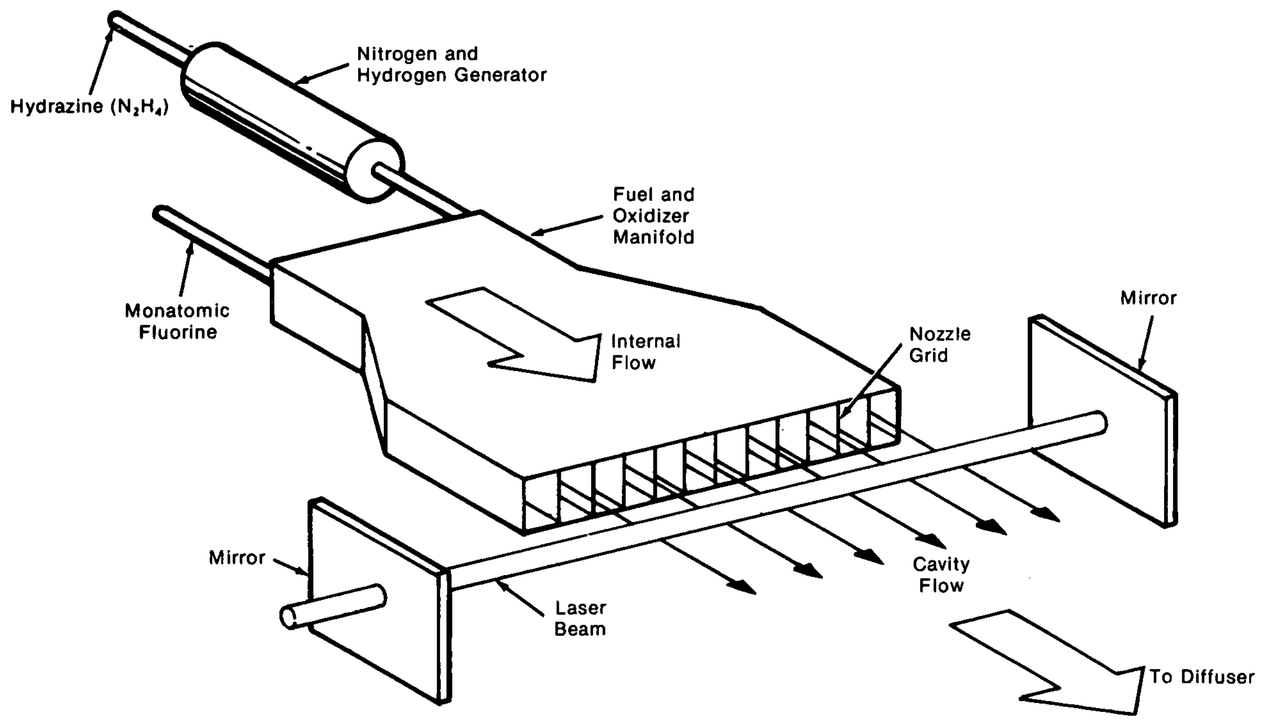
The very exothermic reaction between hydrogen and fluorine has been studied for application in high-power, continuous-wave (CW) lasers. Unfortunately, the lasers based on this reaction are not readily portable. Heavy equipment and large tanks are necessary to store compressed hydrogen and fluorine gases. There is no net advantage when the gases are stored as liquids because additional cryogenic components are needed.

The solution:

A newly proposed approach is to use hydrazine and fluorine. Hydrazine is stored as a liquid in light containers at room temperature and provides the hydrogen necessary for the reaction.

How it's done:

In the presence of a catalyst, hydrazine dissociates exothermally from its original chemical state of N_2H_4 into nitrogen, hydrogen, and ammonia. The ammonia, in the presence of heat, further breaks down into nitrogen and hydrogen. Hence, in one chemical formulation, hydrazine presents the convenience of storage as well as the availability of the reactant hydrogen and the diluent nitrogen. Further investigations of fluorine carriers have shown that there are other fluorine compounds, such as nitrogen tetrafluoride (N_2F_4), that are easier to store and handle than fluorine gas and yet do not introduce any new elements into the final reactions.



Schematic Diagram of Proposed CW Laser

(continued overleaf)

The proposed system is shown in the illustration. Hydrazine is decomposed catalytically and is injected into a combustor. The resulting hot gases are so distributed that a small quantity is introduced into a fluorine-rich combustion plenum (not shown) to cause the formation of monatomic fluorine by the thermal dissociation of diatomic fluorine. The remainder of the decomposed hydrazine is introduced through a separate plenum/nozzle assembly where it is accelerated through the nozzle prior to being combined downstream with the newly-generated monatomic fluorine, which is also accelerated through a nozzle prior to final burning. The reaction of hydrogen and monatomic fluorine produces the excited hydrogen-fluoride molecules required for a conventional hydrogen-fluorine CW laser.

Deuterium can be substituted for hydrogen in the hydrazine formulation to form heavy hydrazine. Conventional hydrazine could still be introduced into the fluorine-rich combustion plenum to generate monatomic fluorine. The heavy hydrazine, however, would be decomposed through a second gas generator and would be introduced through a separate plenum/nozzle assembly. The reaction of the deuterium would occur with the monatomic fluorine to form excited deuterium-fluoride molecules. This reaction is even more desirable because the wavelength generated is less affected by atmospheric water vapor.

Note:

Requests for further information may be directed to:

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Patent status:

NASA has decided not to apply for a patent.

Source: Philip I. Moynihan of Caltech/JPL (NPO-13623)

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