The compression of a pellet consisting of fissionable material, such as U233, U235 or Pu239, to high densities by a laser- (or possibly relativistic electron-) beam induced implosion, will lead to very small critical masses. The critical mass can be furthermore substantially reduced by simultaneously compressing the pellet together with a neutron reflector. By this method micro-fission-explosions can be triggered which can be used for controlled power production as for a safe fast breeder reactor or for rocket propulsion. In addition, if the neutron reflector consists of thermonuclear material, such as T-D, the controlled release of thermonuclear energy becomes possible. In this case the fission chain reaction not only will assist in the ignition of the thermonuclear reaction but in turn the neutrons released in the fusion process will accelerate the fission chain reaction to a very fast pace. Both processes, the fission chain reaction and the fusion process are thus coupled in a bootstrap mode greatly increasing the energy output.

INTRODUCTION

It has been shown\(^{(1,2)}\) that very high densities can be possibly achieved by the laser induced implosion of a spherical mass. The purpose for this proposed implosion technique was to achieve high densities in laser produced thermonuclear plasmas. In principle, the same implosion technique should be also possible with relativistic electron beams which have been previously proposed\(^{(3)}\) as an alternative to laser beams for the controlled release of thermonuclear energy by micro-explosions. Rather detailed calculations predict for this implosion method pressures up to $\sim 10^{18}$ dyn/cm\(^2\). If hydrogen at low temperatures with a Fermi electron distribution is subjected to this pressure its density will rise to a value which is $\sim 10^4$ times larger than its solid state density. The importance of this is that an increase in density will lead to a decrease in the required laser energy for breakeven, whereby the reduction in the required energy input is inversely proportional to the achieved density.

In this communication however, we will discuss another extremely interesting prospect which is, that by these implosion techniques the critical mass of a fissionable assembly can be reduced to such a degree that a fission micro-explosion becomes possible\(^{(4,5)}\). This therefore may lead to an entirely new kind of nuclear fission reactor from which the energy is extracted by a chain of small fission explosions rather than by a continuous steady state energy chain reaction. Such a reactor would be conceivable cheaper and have less serious material problems than a conventional type of fission reactor. Moreover, since the maximum fission energy released is limited by the relatively small size of the micro-fission explosion, the concept could be used for a safe fast breeder reactor. Another important application of this concept is for rocket propulsion whereby the micro-explosions would take place in the focus of a concave reflector.

Finally the possibility of such micro-fission-explosions would raise a new prospect for controlled thermonuclear energy release by surrounding the fissionable pellet with a neutron reflector of thermonuclear material to be implosion-compressed together with the pellet to high densities and subsequently ignited by the energy release of the fission chain reaction. In this case the neutrons released by the thermonuclear fusion process can greatly accelerate the pace of the chain reaction and with it the energy yield.