Outstanding problems include integration of compact optical sources, optical components, and microfluidic components into an easily manufacturable design; and improving the cost and properties of Abs and Ab bioconjugates.

(1) We optimized procedures for covalent immobilization for Abs on silica surfaces. We found that 20–50% of a theoretical Ab monolayer could be achieved, and measured immobilized Ab dissociation constants on the order of 10^{-7} Molar, demonstrating functional attachment. We made flow-through immunosensors with micromolar sensitivity thresholds.

(2) We found compact near-infrared (NIR) diode lasers combined with suitable NIR fluors (cyanine dyes) to be preferable for fluorescence biosensors. We tested compact diode-pumped YAG (532 nm) lasers with fluors such as BODIPY and rhodamine, but encountered excess background fluorescence from optics and biomolecules. Minimizing discrete optics and utilizing modular fiber-optic components maximized flexibility of system configurations.

(3) We found a novel hollow-fiber multimode waveguide to be capable of exciting and capturing fluorescence on its surface using evanescent-wave coupling. This design can be manufactured inexpensively, and covalent attachment of Abs using organosilane crosslinkers can be accomplished using flow-though techniques.

(4) We were able to produce recombinant Abs to tetanus toxin in a baculovirus expression system. We also used nontoxic recombinant toxin fragments for safe sensor development.

We recommend the following:

(1) Optimize covalent attachment techniques for attachment of monoclonal anticlostridial Abs to optimize sensitivity.

(2) Fabricate second-generation hollow waveguides using ceramic claddings and characterize efficiency of excitation and fluorescence collection.

(3) Continue work on expression of recombinant anticlostridial Abs to increase expression levels, and create materials for regenerable Ab surfaces (e.g., Ab-avidin fusion proteins).

Moving Mass Trim Control for Precision-Strike Warheads

B. R. Sturgis, R. D. Robinett

Precision-guided warheads are critical to improving the effectiveness of nuclear and conventionally armed strike systems. This research project will develop a validated simulation tool for the design and evaluation of moving mass controllers on precision-guided reentry systems. The simulation tool will include a multiple-body dynamics model, an autopilot model, and a guidance system algorithm. Sandia will design, build, and test a prototype moving mass controller, based on the Mk4 reentry body, for the purpose of gathering experimental controller performance data. We will use the data to validate the modeling and simulation process.

We accomplished the following in FY96:

(1) Developed two guidance algorithms for the moving mass controller. We chose one for use in the final simulation tool.

(2) Integrated the general-purpose simulation tool, the autopilot, and the guidance algorithm.

(3) Completed several detailed system simulation studies to assess the overall performance and to refine the moving mass controller design. The moving mass controller hardware was redesigned as a result of some of these simulations.

(4) Completed 90% of the mechanical design of the moving mass controller hardware.

(5) Procured long lead items needed to build the prototype moving mass controller.

Results from simulation studies indicated the need for a moving mass unit that takes up less volume and consumes less power than the original hardware design. The redesigned hardware accomplishes this goal.

System simulations indicate that moving mass controllers are capable of removing inaccuracies introduced by booster pointing errors, ablation effects, etc. Since the moving mass unit is internal to the reentry vehicle, there is no change in the aerodynamic properties of the reentry vehicle. This means that a moving mass retrofit to an existing system may be performed at relatively low cost.

Publications

Refereed

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Counterproliferation? for BMD.