APPENDIX F

MASS-PRODUCTION OF TARGETS

BY

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Mass Production of Direct Drive IFE Targets

by

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at

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Cooperation will be required of all concerned for IFE to succeed

- Target design
- Target fabrication
- Filling
- Layering
- Injection and tracking
- First wall/chamber interactions
- By-product removal and recycle
Total cost of target delivered to tank center must be considered

- Cost goal for filled and layered target, delivered to tank center: ~$0.25
- Delivery rate: 5 per second = 0.4M per day = 157 million per year
- Mass production techniques will be required to meet cost and throughput goals
- Automation of fill, layering and injection will be required
- Two approaches toward fabrication of affordable targets for IFE
  - Figure out how to economically make ignition targets based on ICF target designs and ICF target fabrication techniques
  - Invent new mass fabrication techniques to produce IFE targets
What are the characteristics of potential target fabrication techniques

- Characteristics of ICF target production processes
  - Flexible
    - Easy to change target fabrication parameters
    - Easy to change target design
  - Low cost for short production runs
  - Low yield (often)
  - Labor intensive
  - Extensive product characterization

  Note: No target quality foam shells have ever been made and characterized at any size

- Characteristics of high rate commercial production processes
  - Inflexible
    - Optimized for a single product design
    - Optimized for a narrow range of product parameter variations
  - Low cost for high rate production
  - High yield
  - Capital intensive
  - Statistical process control sampling
Conceptual foam shell fabrication techniques

- Fabrication of open cell foam shells
  - Micromachining
    - Produce bulk low density foam
    - Micromachine hemishells
  - Microencapsulation
    - Produce gel shells via 3-fluid nozzle
      - Polymerization – monomers A and B polymerize in a solvent to form an insoluble network (RF)
      - Precipitation – a polymer dissolved in a solvent precipitates as an insoluble network due to a temperature change (TPX)
    - Harvest
    - Extract solvent via supercritical fluid technique
      - Limited experience base
  - Considerable laboratory development
  - Limited experience base – Expensive!!!

- Coating foam shell
  - GDP (Gas Discharge Polymer) – can produce doped polymer
    - Bounce pan
    - Tilted rotary pan
    - Rotary kiln style apparatus
    - Fluidized bed apparatus
  - Standard ICF technique – Expensive!!!
  - Limited experience base – Expensive!!!
  - Speculative – potential large scale operation
  - Speculative – potential large scale operation
  - Interfacial polymerization – may allow limited production of doped polymer
    - Begin with harvested wet gel shell
    - Extract central droplet using excess of phase 2 solvent
    - Replace solvent with solvent containing monomer A
    - Harvest
    - Add to immiscible solvent containing monomer B
    - Polymerize A with B at the solvent-solvent interface
    - Harvest
    - Extract solvent via supercritical fluid technique
Potential IFE Target Coating Techniques

- Bounce Pan
- Rotary Pan
- Fluidized Bed
- Rotary Kiln
Speculative foam shell fabrication techniques

- Open cell foam shell with integral coating via 3-fluid nozzle technique
  - Produce gel shells via 3-fluid nozzle via A-B polymerization technique with a known excess of A
  - Use insoluble stripping fluid containing monomer C – polymerize A-C at the interface
  - Harvest
  - Extract solvent via supercritical fluid technique
  - Coat with dopant in fluidized bed or rotary kiln

- Open cell foam shell with integral coating in a rotary mold
  - Partially fill split mold with solvent and polymer
  - Heat to dissolve polymer
  - Cool while rotating to form gel shell
  - Eject
  - Extract solvent via supercritical fluid technique
  - Coat with dopant in fluidized bed or rotary kiln
Rotomold Fabrication of Foam Shells

Open mold and eject gel shell

Inject polymer and solvent

Complete cooling

Heat to dissolve polymer

Rotate to center bubble and cool to gel

*GENERAL ATOMICS*