Endothelium Preserving Microwave Treatment for Atherosclerosis

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### Background

<table>
<thead>
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<th>AVIONIC SYSTEMS DIVISION</th>
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<tr>
<td>NASA JSC/EV41/P. Fink</td>
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<td>13 Feb., 2003</td>
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- Our primary focus is on antennas and electromagnetic systems
- We recently developed and licensed a microwave catheter antenna for cardiac arrhythmias
- We have developed catheter antennas and a system intended for treatment of atherosclerosis
Major Technical Challenges

- Efficient transfer of energy through a small catheter
- High frequencies (short wavelength) due to restricted artery region
- Small, efficient antenna with directionality
- Verification of thermal profile
  - numerical simulation
  - relies on accurate knowledge of material properties
- Clinical testing
### Technology Description

<table>
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<tr>
<th>Open-ended waveguide antenna with bevel</th>
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<tr>
<td>Teflon</td>
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<tr>
<td>Adventitia</td>
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<tr>
<td>Blood</td>
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<td>Media</td>
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Microwave catheter antenna for heating atherosclerotic lesions to reduce constriction in the artery

- Antenna directionality focuses energy to lesions
Current level of development

- Prototyped 2 directional catheter antennas specifically for atherosclerotic treatment
  - Open-ended waveguide with bevel (patented)
  - New directional catheter antenna
    - in disclosure process
- Preliminary computational electromagnetic modeling (CEM) of new directional catheter antenna
- Preliminary simulations of thermal profiles using candidate frequencies, power levels, and heating times
- Performed initial test of energy transfer to lipids
- Initial CEM simulation
  - Ez near feed region
  - Simplified infinitesimal current filament source
    ✓ Demonstrates front/back directionality
Development hurdles

- Comprehensive test program with partner in the medical community

- Verify preservation of intima while supplying sufficient heat to atherosclerotic region
- Balloon angioplasty
- Stents
- Laser ablation
• Disadvantages of current methods
  • Balloon angioplasty
    ✓ Restenosis
  • stents
    ✓ Restenosis in older, non-coated stents
  • Laser ablation
    ✓ Possible destruction of artery
• Advantages of proposed method
  ♦ We anticipate this method will be characterized by:
    ✓ Prevention of restenosis
    ✓ Inexpensive catheterization procedure on an outpatient basis
  ♦ We are also extending this procedure to treat older, non-coated stents
Future R&D

- Comprehensive test program with partner in the medical community
- Future enhancement/extension:
  - possible extension to stents
  - Initiated test with stent in phantom material
- Remaining milestones
  - Test in extracted tissue
  - High fidelity computational model
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<tr>
<th>IP Status</th>
<th>AVIONIC SYSTEMS DIVISION</th>
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<td>5 U.S. patents issued</td>
<td>NASA JSC/EV41/P. Fink</td>
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**NASA Partnership Options**

- Space Act Agreement
  - Cooperative effort to mature the technology
- Eventual licensing of technology