Heated Diagnostic Radiology Exam Table

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1. Abstract

Clinical X-ray examinations sometimes require patients to remain still for over an hour. A common patient complaint is that X-ray examination tables are uncomfortable, specifically they are too hard and too cold. Patient discomfort is undesirable because an uncomfortable patient is more prone to moving during a long procedure. The objective of the client and our team is to create a device that can provide patient comfort while at the same time preserving patient safety and radiolucency.

The device consists of a radiolucent Indium Tin Oxide (ITO) layer deposited on a polyethylene substrate sandwiched between two dielectric Kapton® sheets and polyethylene foam. Finally, the entire device is enclosed in a sterilizable vinyl film. The materials used, in addition to the original x-ray exam table, do not attenuate more than allowed by CFR-Federal Code of Regulations Title 21.

2. Motivation/Market

1	5,815	90.6 million
Minimum number of X-ray tables required per registered hospital [1]	Number of registered hospitals (not including clinics) in the U.S. [1]	Number of X-ray procedures performed in the U.S. in 2001 [2, 3]

3. Design Criteria

- No anatomical distortion
- Safe for patient
  - No possibility of burns
  - Easily sterilizable
  - No risk of patient electrocution
- Heats patient
  - Heats uniformly
  - Rapid heating response
  - Patient/Technician interface to control temperature
- Radiolucent
  - Must not introduce artifacts that may interfere with diagnosis
  - Table and device must not attenuate more than 1 mm of Al
- No obstruction of technician workspace
- Must be softer than current table

4. Expenses

Component	Our Cost	Full Cost
ITO sheet	Free	$217.5*
Kapton® Film	Free	$108.75*
Film/Padding	$7.50	$41.50*
Electronics	$30	$30*
TOTAL	$37.50	$397.75*

*We anticipate these costs to decrease dramatically with mass production

5. ITO Heating Characterization

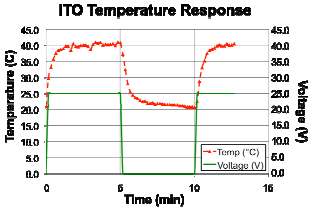
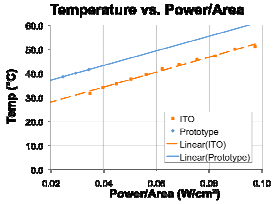
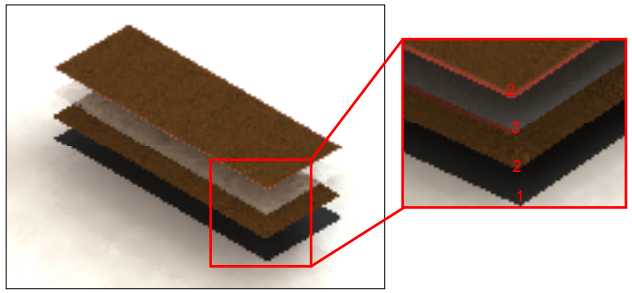


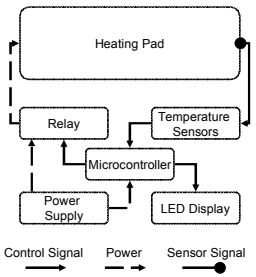
Chart at left:
Temperature response of the ITO film was assessed over time using an infrared thermometer. The response times (<2 min.) were deemed acceptable.

Chart at right:
Temperature at the ITO surface was assessed using an infrared thermometer. Linear relationship between Temperature and Power/Area. Without insulation, these results represent a worst case scenario.



6. Final Design





1. Padding
   - Fine cell polyethylene foam on bottom
   - Provides physical comfort
   - Thermally insulates
2. Electrical Insulation
   - Electrically grounded layer of Kapton® on top and bottom
   - 2,500 V dialectic layer between ITO and Kapton®
3. Heating Element
   - 0.0254 mm thick conductive ITO film
   - Heat generated by passing current through film

7. Prototype Testing

X-ray Image of prototype with head phantom. No artifact introduction between busbars.

X-ray image of the prototype. Using an image analysis program, the device was shown to attenuate less than 3.9%.

8. Conclusion/Discussion

Prototype
- Heated Area
  - 8 cm x 24 cm
  - 3:1 aspect ratio
- Electrical
  - 0.03 Watts/cm²
  - 5.76 Watts
  - 12 VDC
  - 0.472 Amps

Scale Up
- Heated Area
  - 72 cm x 216 cm
  - 3:1 aspect ratio
- Electrical
  - 0.03 Watts/cm²
  - 470 Watts
  - 120 VAC
  - 4 Amps

ITO
- Low resistance
- Flexible

Busbars
- Connection issues
- Limited flexibility

AC Voltage
- Safety
- Convenience

9. Future Work

- Assemble full scale prototype
- Finish patent process with Wisconsin Alumni Research Foundation (WARF)
- Research market and potential licenses
- Test material degradation when exposed to X Rays, repeated use, and sterlization
- Thoroughly test full scale design safety
- Make adjustments to design as needed

10. References / Acknowledgments

1. American Hospital Association. "Fast Facts on US Hospitals." 11 Nov. 2009.
2. Bhargavan, M and Sunshine, JH. "Utilization of Radiology Services in the United States: Levels and Trends in Modlaities, Regions, and Populations." *Radiology*. 2005. 234: 824-832.
3. US Census Bureau. "Section 1: Populations." *Statistical Abstract of the United States: 2001*.
4. Dr. Walter Peppler, Professor, UW Dept. of Medical Physics
5. Dr. Frank Ranallo, Associate Professor, UW Dept. of Medical Physics
6. Dr. Giri Venkataramanan, Professor, UW Dept. of Electrical and Computer Engineering