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 the tables are too hard and too cold. Discomfort is undesirable because an uncomfortable patient is more likely to move during a long procedure resulting in poor image quality and even misdiagnosis. The objective of the client and our team is to create a device that can ensure patient comfort while preserving radiolucency and patient safety.

The device consists of a Kapton® 200RS100 heating element between two dielectric Kapton® sheets and polyethylene foam. The entire device is enclosed in a sterilizable Naugahyde® cover. Infrared imaging determined that heat gradients across the device were small. Image analysis demonstrated that the device did not introduce artifacts or overly attenuate the X-ray beam in accordance with federal regulations.

2. Motivation/Market

90.6 million

Number of X-ray procedures performed in the U.S. annually [1, 2]

~465,000

Number of repeat exams due to patient movement per year [3]

$12.4 million

Total cost of repeat exams annually due to patient movement [4]

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 Aluminum (4.49 percent)
- Cannot obstruct technician's workspace
- Must be softer than current table

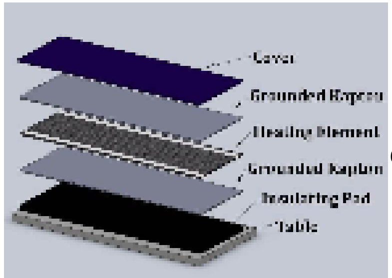
4. Safety

4.1 Kapton® dielectric layer
- Insulates up to 2,500 V
- 25.4 µm thick

4.2 Grounded Kapton® conductive layer
- Conducts stray current away from patient
- 25.4 µm thick

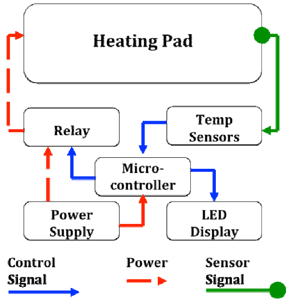
4.3 Ground fault interrupter (GFI)
- Connected to conductive Kapton® layer
- Any stray ground current trips GFI and cuts power to device

6. Final Design



6.1 Cover
- Medical-grade Naugahyde®
- Oil/water resistant
- Anti-fungal
- Anti-microbial
- 500k rub cycles

6.2 Grounded Kapton
- 2,500 V dielectric layer surrounds heating element
- Electrically grounded conductive material surrounds dielectric

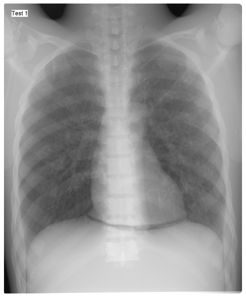


6.3 Heating Element
- 50.8 µm thick conductive Kapton® film
- Heats by resistive heating

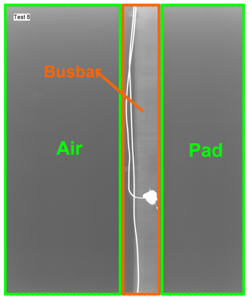
6.4 Insulating Pad
- Fine cell polyethylene foam
- .3175 cm thick
- Provides physical comfort
- Thermally insulates

6.5 Circuit
- Control and monitor temperature
- Display and user interface

5. Radiolucency Characterization



X-ray image of device with chest phantom. Qualitatively, the device did not introduce any artifacts into the image or overly attenuate the signal.



X-ray image of the device alone. Using an image analysis program, the device was shown to attenuate less than 1.1 percent as compared to air.

7. Heating Characterization

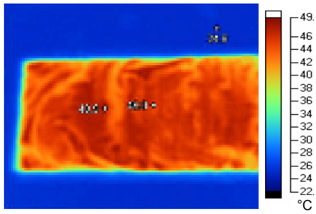


Figure at left:
Infrared image of the pad as it approaches 46 °C. The colormap demonstrates that temperature gradients are small. The few hot spots are due to creases and air pockets. Notice that there are no hot spots at the edges of the pad along the busbars.

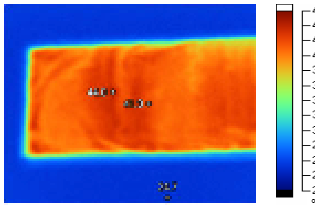


Figure at right:
Infrared image of the powered down pad as it cools back to room temperature from 46 °C. Both images were acquired using using a Ti25 Thermal Imager from Fluke.

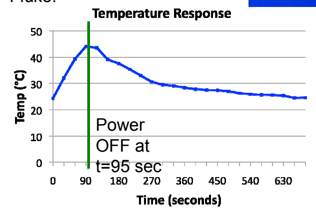


Chart at left:
To characterize the response time of the device, temperature was taken every thirty seconds. The pad reached at target temperature of 44 °C within 95 seconds of powering on (t=0). It was then allowed to return to room temperature.

8. Budget

Item	Prototype cost ($)	Large-scale cost ($)
Naugahyde	43.59	28.33
Circuit components	153.96	45
Kapton	482.02	99
Foam	8.46	5.64
Ag ink and printing	108.45	100
TOTAL	**796.48**	**277.97**
	SAVINGS	**518.51**

9. References / Acknowledgments

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5. Prof. Walter Peppler, UW Medical Physics
6. Prof. Dr. Frank Ranallo, UW Medical Physics
7. Prof. Giri Venkataramanan, UW ECE
8. Mitch Tyler, UW BME
9. Dr. Michael Kissick, UW Radiology
10. Cindy Statz, UW Physical Plant
11. Danny Glenn, DuPont
12. Jonathan Crumpton, DuPont
13. Robert Waldrop, DuPont
14. Carl Haeger, DuPont
15. Prof. John Hitchcock, UW Art
16. Don Graff, Mosehart-Schleeter
17. Prof. Mike Morrow, UW ECE