Plasma Technology: A Sustainable Approach for Textile Finishing

By
Shital Palaskar & A. N. Desai
Theme of Presentation

- Introduction
- Plasma
- Aim
- Experimental
- Results
- Conclusions
BTRA Activity Profile

The Bombay Textile Research Association
Mumbai
Bombay Textile Research Association (BTRA) Mumbai, India

- BTRA was established in 1954 as research association by textile mill owners of Mumbai. It is a all India body catering to needs of Indian textile industries.

- The mandate is to undertake research and other scientific work in connection with the textile trade or industry and other trades or industries allied therewith or accessory thereto.
Main Activities

**Technical Services**
- Consultancy in all aspects of textiles
- Utilities / Conservation
- Quality & Environment Management
- Decentralised Sector

**Training Services**
- HRD
- Need based training

**Research Projects**
- Government funded
- In house

**Testing Services**
- Physical and chemical testing
- Polymer and Eco-Parameters testing
- Technical textiles / composites testing
- Microbiology

For more details:
[Website- www.btraindia.com](http://www.btraindia.com)
[Email-btra@vsnl.com](mailto:btra@vsnl.com)
-91-022-2500-2652
-91-022-2500-3652
Sustainable development” is development that meets the need of the present without compromising the ability of future generations to meet their own needs

--Brundtland report
What is Plasma?
## Why Plasma?

<table>
<thead>
<tr>
<th></th>
<th>Plasma processing</th>
<th>Traditional wet chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>Treatment by excited gas phase</td>
<td>Water-based</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Water consumption</td>
<td>Negligible</td>
<td>High</td>
</tr>
<tr>
<td>Reaction type</td>
<td>Complex &amp; multifunctional</td>
<td>Simpler, well established</td>
</tr>
<tr>
<td>Reaction location</td>
<td>Highly surface specific, no effect on bulk properties</td>
<td>Bulk properties generally affected</td>
</tr>
<tr>
<td>Environmental effect</td>
<td>Eco- friendly</td>
<td>polluting</td>
</tr>
<tr>
<td>Potential for new process</td>
<td>Great potential, field in state of rapid development</td>
<td>Very low, technology static</td>
</tr>
</tbody>
</table>

Plasma technology for textile, R. Shishoo
Possible Applications of Plasma

- **Plasma application areas**
  - Dyeing and Printing
  - Composites
  - Anti-felting of wool
  - Flame Retardant
  - Hydrophobic
  - Oil Repellent
  - Hydrophilic

- **Possible Applications**
  - BTRA
  - SEM images of nanomaterials
Why We Need Multifunctional?

- Loss due to Fire
- Harmful effect of UV rays
- Effect of bacteria on human health
Aim

- Flame Retardant
- UV protective
- Antibacterial

Multi-functional
Experiments

The Plasma Machine is from GRINP - www.grinp.com
### Ultraviolet Protection Factor (UPF) as per AU/NZS 4399

#### Results

<table>
<thead>
<tr>
<th>UPF Rating</th>
<th>Protection Level</th>
<th>% UV radiation Blocked</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-24</td>
<td>Good</td>
<td>93.3-95.9</td>
</tr>
<tr>
<td>25-39</td>
<td>Very Good</td>
<td>96.0-97.4</td>
</tr>
<tr>
<td>40-50+</td>
<td>Excellent</td>
<td>97.5-98+</td>
</tr>
</tbody>
</table>

#### Graph

- **Tio2 0.5%**
- **Tio2 1%**
- **Tio2 1.5%**
- **control**

**Y-axis:** UPF value

**X-axis:** Before wash, After 5 wash, After 10 wash, After 15 wash, After 20 wash
### Flame Retardancy

**45° Inclined Flammability**

<table>
<thead>
<tr>
<th>Sample</th>
<th>LOI (ASTM 2863)</th>
<th>Flame application time (Sec.)</th>
<th>Burning time (Sec.)</th>
<th>Pass/fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Cotton</td>
<td>18.1</td>
<td>2</td>
<td>3.5</td>
<td>fail</td>
</tr>
<tr>
<td>TiO₂ 0.5%</td>
<td>27.5</td>
<td>3</td>
<td>24.2</td>
<td>pass</td>
</tr>
<tr>
<td>TiO₂ 1%</td>
<td>30.7</td>
<td>3</td>
<td>27.3</td>
<td>pass</td>
</tr>
<tr>
<td>TiO₂ 1.5%</td>
<td>30.8</td>
<td>3</td>
<td>26.9</td>
<td>pass</td>
</tr>
</tbody>
</table>
Thermo Gravimetric Analysis

- Control
- TiO2 1%
- TiO2 1.5%
# Antibacterial (As per AATCC 100)

<table>
<thead>
<tr>
<th>Sample</th>
<th>% Reduction Before wash</th>
<th>% Reduction After 20 wash</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S. aureus</td>
<td>K. pneumoniae</td>
</tr>
<tr>
<td>Control cotton</td>
<td>No reduction</td>
<td>No reduction</td>
</tr>
<tr>
<td>TiO2 0.5%</td>
<td>96.24</td>
<td>99.56</td>
</tr>
<tr>
<td>TiO2 1%</td>
<td>95.24</td>
<td>98.66</td>
</tr>
<tr>
<td>TiO2 1.5%</td>
<td>99.66</td>
<td>99.6</td>
</tr>
</tbody>
</table>
Surface Analysis by SEM

(a) control cotton
(c) finished with 0.5% TiO₂
(b) Plasma Treated cotton
(d) finished with 1.0% TiO₂
### Comparative Study

30% less chemicals were used with plasma finishing to study the cost effectiveness of plasma finishing.

<table>
<thead>
<tr>
<th>Process parameters</th>
<th>Samples 1 (Conventional method)</th>
<th>Samples 2 (Plasma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag nano</td>
<td>150 ppm</td>
<td>100 ppm</td>
</tr>
<tr>
<td>TiO₂/SiO₂</td>
<td>1.5%</td>
<td>1%</td>
</tr>
<tr>
<td>BTCA/SHP</td>
<td>8%</td>
<td>6%</td>
</tr>
</tbody>
</table>
Results of plasma treated sample with 30% less chemicals
## Available Market for Multifunctional Fabrics

<table>
<thead>
<tr>
<th>Customer</th>
<th>Health Care Industry</th>
<th>Personal Protective Clothing</th>
<th>Flame Retardant Textiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need/problem</td>
<td>Cross infection due to presence of bacteria</td>
<td>Change in atmosphere boosted demand for special fabrics</td>
<td>Fire hazards, loss of life, property.</td>
</tr>
<tr>
<td>Our solution</td>
<td>Antibacterial product</td>
<td>U V Protective</td>
<td>Flame retardant cotton fabric</td>
</tr>
<tr>
<td>Market size</td>
<td>€ 407 million</td>
<td>€ 13.5 million</td>
<td>€ 50 million</td>
</tr>
<tr>
<td>CAGR %</td>
<td>11.8</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

Ref.- Baseline survey of the technical textile industry in India, Mar2014 iMaCS
“Multi-Functional Finishing of Textile using Eco-friendly Plasma Technology”

Bagged the prestigious DST - Lockheed Martin India Innovation Growth Programme award 2014

- Patent Filed for Multi-functional cotton fabric
- One PCT is Filed

The Technology will be transferred soon
Thank You

You may visit our stall

Hall 8 Stall A130