

PolyU STEM Lecture Series

STEM in Care Apparel for Better Living

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Care Apparel with adaptive design
basically can help the elderly or
disabled who encounter various
clothing problems

Main Functions of Care Apparel

A. Functional Needs:

- a. facilitate the dressing and undressing process



b. provide protection to prevent the wearer from injury



c. enhance the acceptance and compliance of medical treatment





d. other special function



B. Psychological Needs:

- provide a more dignified appearance to the client, thus enhance their self image and social acceptance





Development of Care Apparel

- Improvement on the comfort and aesthetic value of the garment. The demand on Psychological Needs is increasing.



Development of Care Apparel

- More demands to support the medical application, health monitoring, and health care management.
- Development of Care Apparel with technology comes from different disciplines. e.g., Fabric Technology, Information Communication Technology (ICT), Chemical technology, etc.

Example One:

Development of a Smart Diaper for Healthcare

- Functions of the Smart Diaper:
 - To measure the degree of wetness inside the diapers, and the body temperature of the wearer.
 - To provide alert message to the caretaker when the degree of wetness is reached to a pre-determined level.
 - To monitor the incontinence condition of the wearer for health care management.

Key Issues in the Development of the Smart Diaper

- The selection of appropriate wetness sensor that would not easily overwhelmed and lost its sensitivity by urine.

A radio-frequency (RF) wireless wetness sensor of size small enough to be embedded in the diaper is chosen for the wetness measurement.

- The smart diaper composed of two parts:
 - a) the diaper which will be stained by urine is disposable;
 - b) a non-disposable belt which consists of the Transmitter of the RF communication system.



- A couple of metallic strips which are connected with 3V DC power are used as the sensor for detecting the degree of wetness.



- The difference of electric potential of the two electrodes decreases with the amount of urine increases.
- The degree of wetness (%) is worked out based on the voltage measured by the sensor.

Limitations of Smart Diaper

- Caretakers need to spend more time for changing the diapers. The way to connect and disconnect the transmitter with the metallic strips should be simplified.
- The cost to insert the metallic strips into the diaper is not cheap for disposable products.
- The size of the transmitter still not small enough.

Example Two:

Adults Bibs used at Elderly/Caring Home

- **Structure of Current Adult Bibs:**

Most bibs are constructed of cotton flannel to absorb saliva or fluid and with a fully vinyl waterproofing backing to protect the surrounding area from stain.

Drawbacks of Current Adult Bibs

- Differential shrinkage of different material sewn together would cause wrinkles appear seriously after the bib has been washed.
- The coating of the PU material or other fabric finishing may crack and lose the function after repeat washing in particular under high temperature.



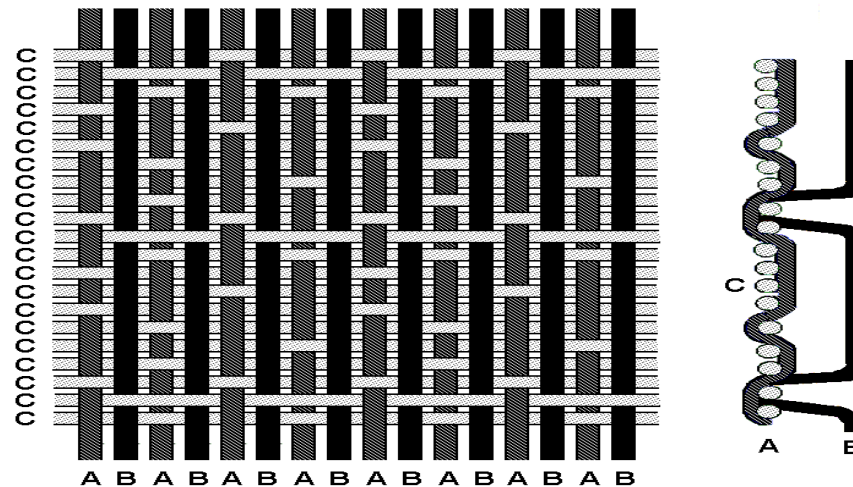
Key Issues in developing Durable Adult Bibs

- The textile material for making the bibs should be high absorbent at the surface and with waterproof properties at the wrong side.
- No chemical treatment would improve fabric durability under high temperature washing, and also avoid allergy to wearer.
- Maintain good fabric hand and no dimensional change after repeated laundering at high temperature.

Technology used in the Fabric Development

- The state-of-arts terry cloth weaving technology is used.
- The terry surface is made of natural fiber and interlace with synthetic fibers at the back side.

圖示在織物結構上地經紗/絨經紗與緯紗交織規律



A = 地經紗	A= Ground Warp Yarn	20/2 dyed cotton yarn
B = 絨經紗	B= Loop Warp Yarn	20/2 dyed cotton yarn
C = 緯紗	C= Weft Yarn	240Dpolypropylene fiber rope

Technology used in the Fabric Development

- Very high intensive fabric density at the back side is essential for water resistance purpose. (Warp x Weft 56 x 163)
- The fabric will be scoured and bleached to enhance absorption and fabric hand .



Example Three:

Care Apparel with Traditional Chinese Herbal Medicine (TCHM) for Treating Atopic Dermatitis

- **Atopic Dermatitis (AD)**

is a inflammatory skin disease characterized by intense itching, dryness, flares up, erythema, raised bumps, rash and even pustules etc.,

Some patients with severe AD may present excoriations, and serous exudates due to persistent scratching.



- It is the most common dermatological disorder among children.
- It is not completely curable ; thus most patients experience a chronic course of this disease.

Treatment of Atopic Dermatitis

- **Clinical Medication:** the use of moisturizers or emollient cream to control dryness; the use of topical or systematic corticosteroids and/or drugs to control flares, relief of pruritus and minimization of infection risk.
- **Wet-wrap dressing:** usually in form of a double layer tubular bandage or gauze, and is used as complementary therapy and/or a type of drug / moisture carrier.
- **Traditional Chinese Herbal Medicine:** The dosage is generally administrated orally in formed as pills, capsules and decoctions etc.

Drawbacks of Existing Treatment Methods

- The prolonged use of drugs may have adverse effects such as thinning of skin, stretch marks, hypertension or even growth retardant in children.
- Wet wrap dressing normally lasts only an hour, and the wet and cool feeling on skin may make the patients feel uncomfortable.
- It is unable to prevent the patient to scratch skin with AD.

Advantages of Using Care Apparel with TCHM microcapsules

- The microencapsulation has been applied in the fields of cosmetics and drug delivery system due to its controlled release properties of the encapsulated substance by different stimulation such as friction, pressure and temperature.
- The use of apparel can reduce the skin damage due to scratching. It is easy to apply on patients and suitable for prolong use.

Key Issues in developing TCHM Microcapsules

- **Selection of TCHM for the atopic dermatitis treatment:**

Pentaherbs which contains Cortex Moutan, Cortex Phellodendri, Flos Lonicerae, Herba Menthae, Rhizoma Atractylodis are anti-allergic, anti-inflammatory, anti-pruritic, and positive at treating AD.

- **The selection of appropriate microcapsules for containing the TCHM:**

The microcapsules should not have toxic effect on cells. The Chitosan–Sodium Alginate (CSA) have been widely used as wall materials of microcapsules due to non-toxicity, good biodegradability and high biocompatibility.

Encapsulation efficiency is determined by the yield percentage.

$$\text{Yield percentage} = \frac{\text{(Weight of drug in microcapsules)}}{\text{(Weight of feeding drug)}} \times 100\%$$

- The microcapsules should have a good controlled release of drugs over a long period of time.

Other than the breakage of microcapsules wall shells during wear, the drugs should be able to release in the presence of humidity and body temperature.

The average pH of sweat of a normal healthy boy and girl is 5.0 and 5.4 respectively.

Release Profiles of Microcapsules with TCHM

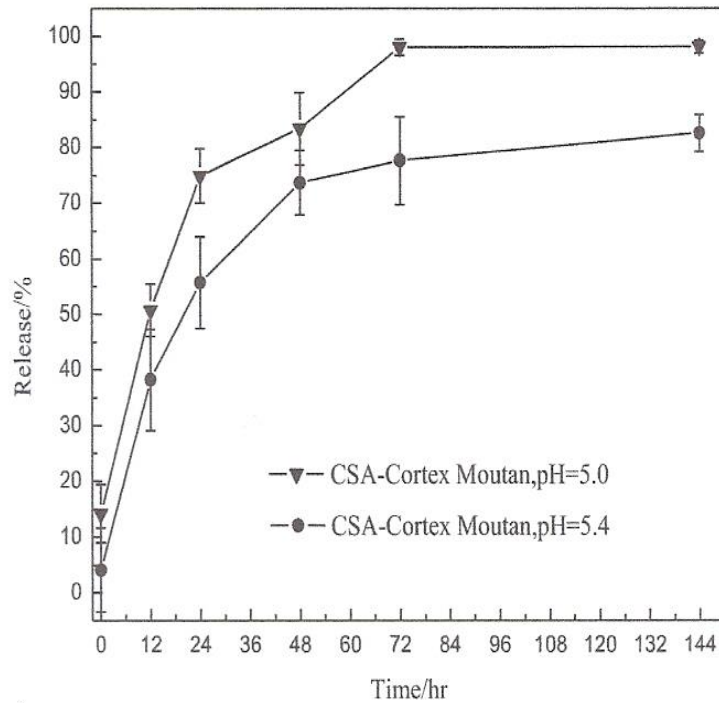


Fig. 5. Release profiles of gallic acid from CSA microcapsules immersed in PBS of pH 5.0 and pH 5.4 ($n=3$).

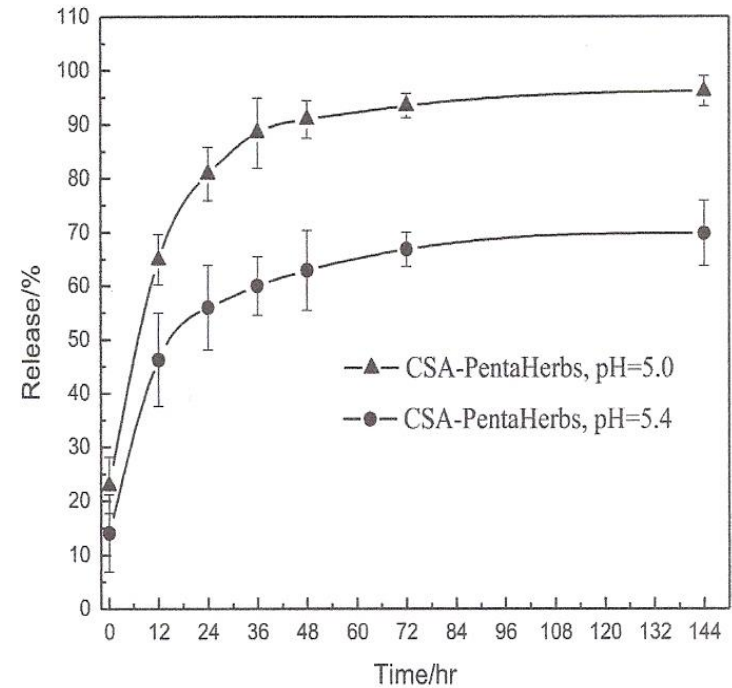


Fig. 5. Release profiles of gallic acid from CSA microcapsules immersed in PBS of pH 5.0 and pH 5.4 ($n=3$).

Limitations:

- The size of microcapsules which contains the TCHM for the dosage of effective AD treatment is not yet satisfactory.

Further research to reduce the molecular size of the herbal extract and also the encapsulation technique is needed.



Knowledge Transfer to Community: Troels H. Povlsen Care Apparel Centre

- Objective: It provides special clothing services for the elderly and disabled to enhance their quality of life, boost their confidence and allow them to live with dignity.
- Main activities include education, consultation, research and development, and servicing to the community.
- Enquiry: Room W204, podium level, The Hong Kong Polytechnic University, Hung Hom, Kowloon. (e-mail: tccac@polyu.edu.hk; and tel. no.: 34003369)



Conclusion :

- The development of care apparel is not limited to adaptive design.
- Care Apparel is designed in cooperate with cross discipline technology.
- Textile and wearable technology would integrate into the future care apparel products.

Thank You!

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