



# Mehran University of Engineering & Technology SZAB Campus Khairpur Mir's

- ✓ **Topic:** To Design & Develop Simulation Model for phase change material based All-Weather-Jacket.
- ✓ **Supervised by:** Engr. Abdul Ahad Noohani

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# Introduction PCM(s)

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- ❑ Phase Change Materials or PCM(s) are those that can **absorb, store and release** large amounts of energy, in the form of **latent heat**, over a narrowly **defined phase change range**, during which the **material changes state**.
- ❑ In particular, the energy storage materials such as phase change materials (PCMs) that are **added into textile fibers** are also an **effective method to fabricate thermo-regulation smart textiles**.



Fig. 01

# Introduction PCM(s)

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- More than **500 natural and synthetic** PCM(s) are available, based upon:
  - 1. Phase change temperature ranges**
  - 2. Heat storage capacities.**

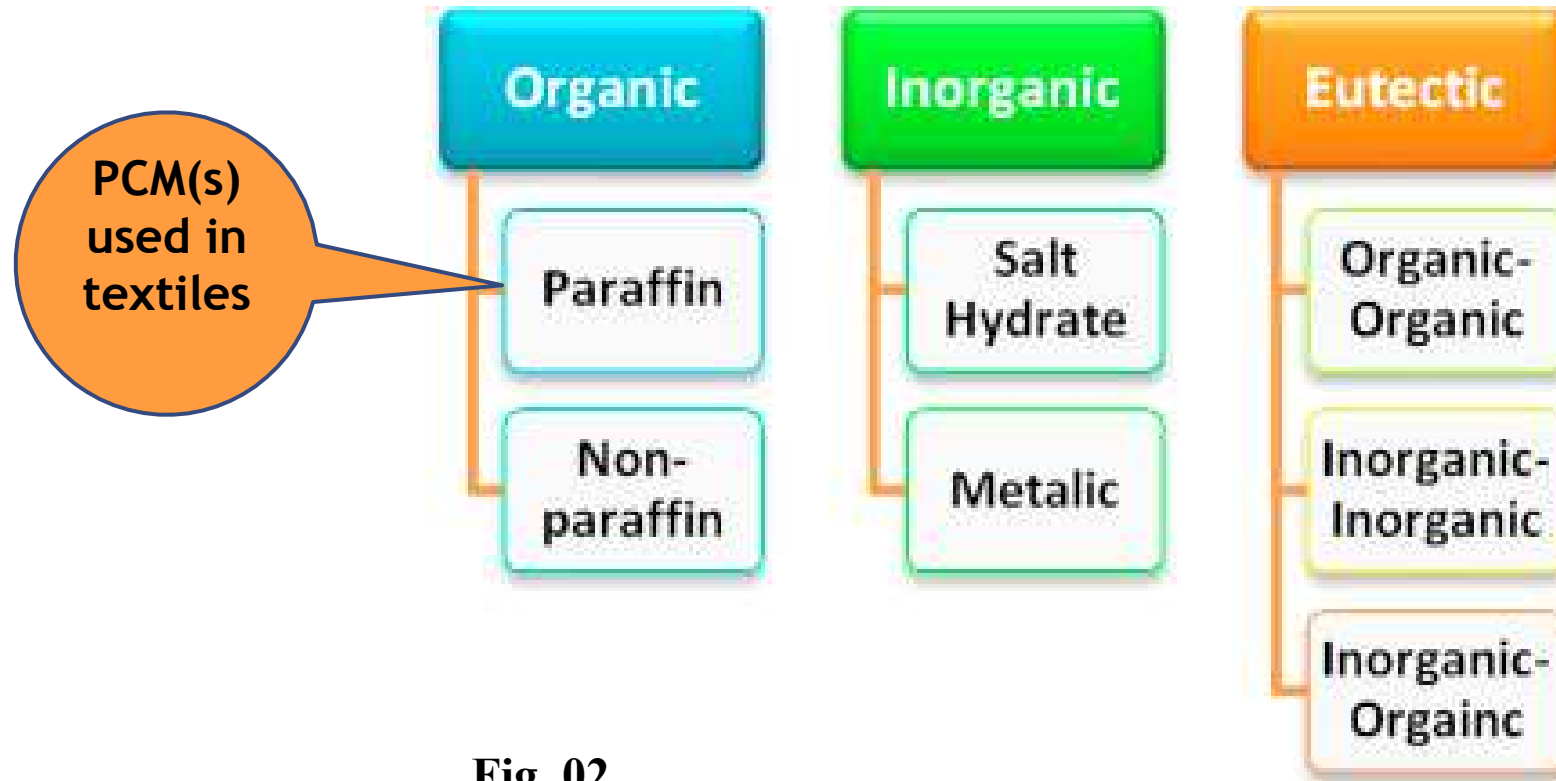


Fig. 02

# Working of PCM(s) in Textiles

- When a PCM based material is facing a rise in temperature due to external or internal conditions, its solid phase encapsulations starts absorbing heat energy under constant temperature and change to a liquid phase, thus providing a cooling effect to the user and vice versa.

- PCM fabric referred as “Active Smart Textile”, capable of sensing and reacting to the conditions or stimulus.

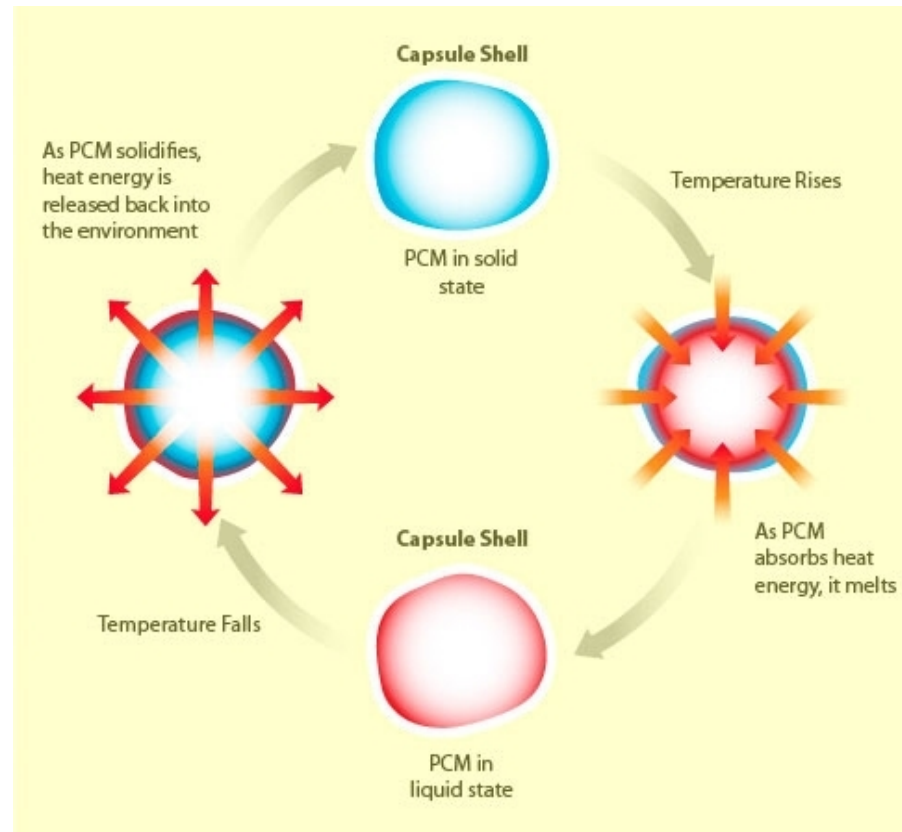


Fig. 03

# Problem Statement

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- ❑ People living or **working in the frosty or hot environment** have shown the **need for clothes that can keep them warm in cold season and cool in warm season.**
- ❑ Traditional clothes are unable to fulfill such requirements, **“Smart Textiles”** is the only way to overcome such requirements as **these (Smart-Textiles) are capable to sense and response to the outdoor conditions.**
- ❑ If PCMs are integrated into the textiles, the **insulation capacity** of the **textiles** can be greatly **improved**, due to large **thermal storage capacity** and almost **constant phase change temperature** of PCMs.
- ❑ People want to wear dress which is suitable and **comfortable for all seasons** .
- ❑ Many attempts have made to develop a **jacket that can be worn regardless of any season** of the year as it works in different climate zones.



# Aims & Objectives

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- ❑ This research aims to design & develop such PCM(s) based jacket that regulate body temperature, i-e no change in temperature of the encapsulated PCM(s).
- ❑ Based on comfort, geometrical, mechanical, and thermal characteristics, which give insight into heat management through clothes to produce outdoor and protective clothes.

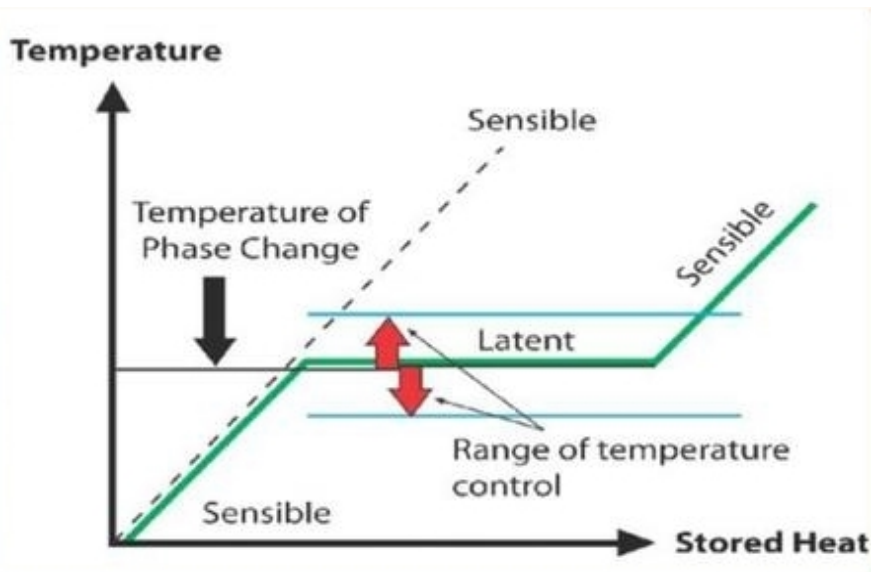


Fig. 04



Fig. 05

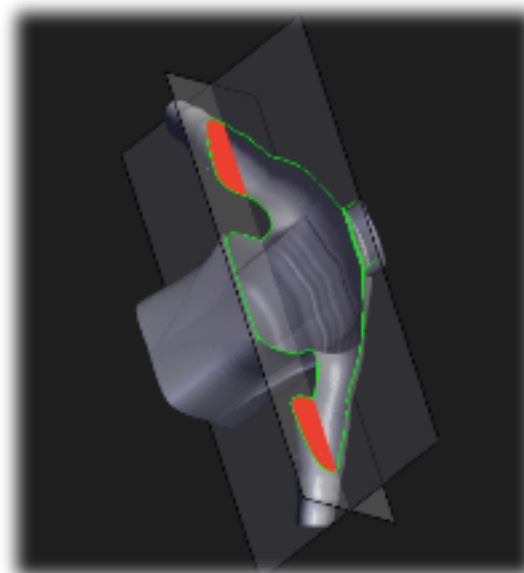
# Aims & Objectives

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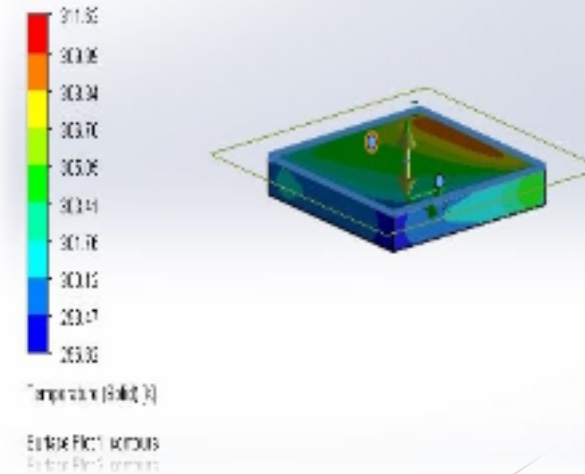
- This conceptual framework particularly comprises the following **Objectives**.
  1. Development of **2D Sketching** and **3D Model** on **SolidWorks** of **PCM(s) based Jacket**.
  2. **To Simulate** PCM based Jacket.
  3. To study the **geometrical model & thermal characteristics** and **comparing results with prototype**.



**Fig. 06**



**Fig. 07**



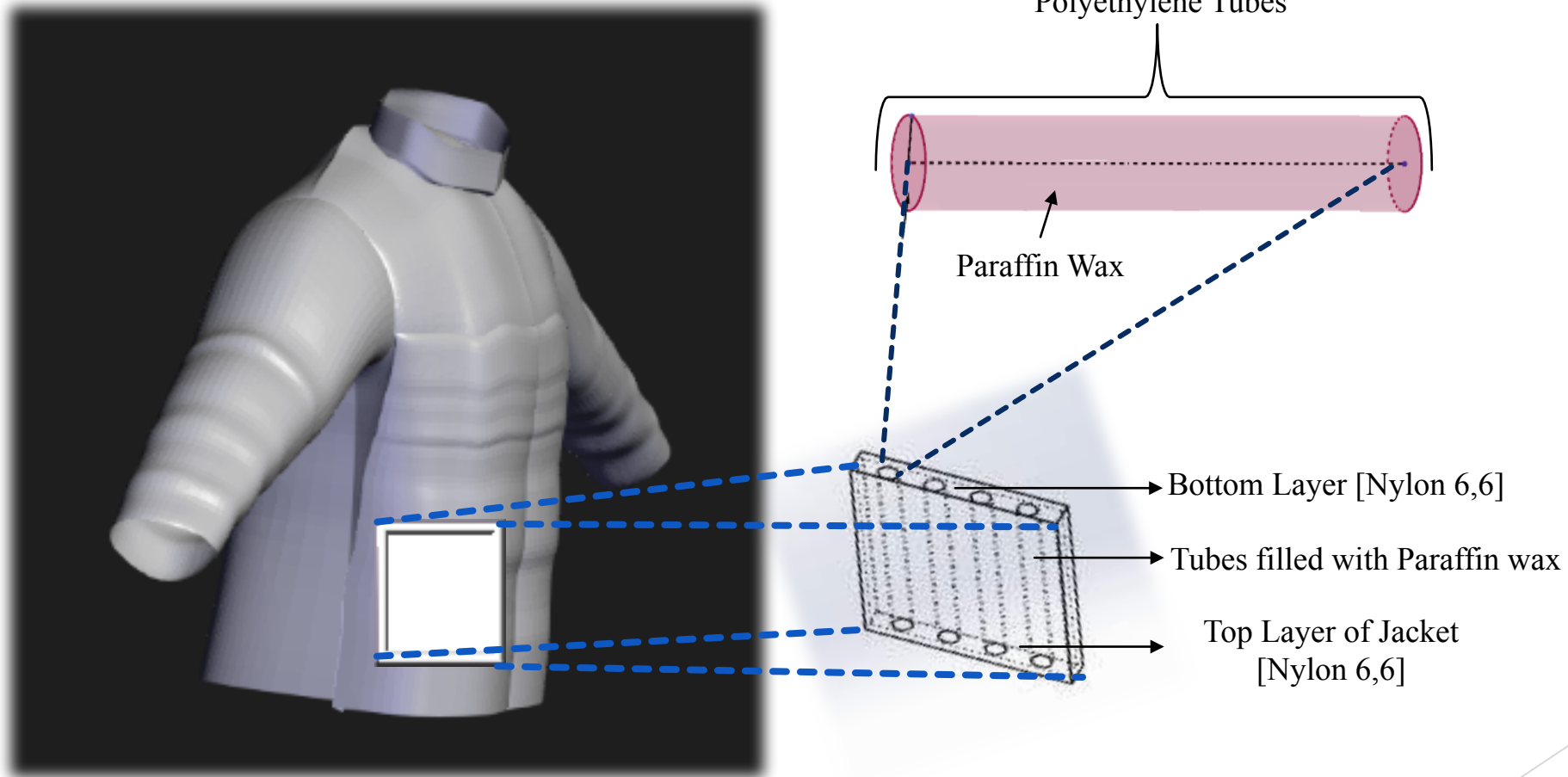
**Fig. 08**



# Aims & Objectives

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- A cross Sectional 3D View of the Jacket [three layers].



**Fig. 09**

# Literature Review

	Title	Authors	Findings	Year
01.	Design & Development of All Weather Jacket by Using Phase Change Material.	R. L. Gotipamul, A. U. Thorat, P. Bhausheb, S. Shridhar, C. Revatgaon, and A. P. Jadhav	<ul style="list-style-type: none"><li>○ They have researched, jacket has three layers which are an external water repellent, breathable nylon fabric layer, a middle layer of a nonwoven thermal bonded fabric, an internal cotton fabric layer.</li><li>○ The Combination of fabrics with paraffin wax (as PCM) shows good results towards functionality as per the consumer survey of a jacket.</li></ul>	2018
02.	TEXTILES INTEGRATING PCMS – A REVIEW.	E. Onofrei, A. M. Rocha, and A. Catarino	<ul style="list-style-type: none"><li>○ Paraffin is the preferred kind of PCMs for textile applications b/c melting point of paraffin is very close to temperature of the body.</li><li>○ These are enclosed in a microcapsule to prevent leakage of material during its liquid phase.</li></ul>	2010

# Literature Review

	Title	Authors	Findings	Year
03.	SMART FUNCTIONAL TEXTILES CREATED BY THE APPLICATION OF MACRO-ENCAPSULATED PHASE CHANGE MATERIAL	B. Pause	<ul style="list-style-type: none"><li>○ A phase change material (PCM) absorbs or releases a large amount of so-called “latent heat” in a material specific temperature range while its temperature remains nearly constant. .</li></ul>	2019
04.	Phase change materials, their synthesis and application in textiles— a review	Kashif Iqbal, Asfandyar Khan, Danmei Sun, Munir Ashraf, Abdur Rehman, Faiza Safdar, Abdul Basit & Hafiz Shahzad Maqsood	<ul style="list-style-type: none"><li>○ This review paper summarizes the investigation and analysis of the available organic and inorganic PCMs, different encapsulating techniques, characterization techniques, incorporation into fiber and pad application on textiles with practical applications in the field of smart textiles</li></ul>	2019

# Design & Material Selection

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- ❑ Required properties of PCM(s) in Textiles
  1. Melting point between 18 and 35 °C.
  2. Large heat of fusion.
  3. Small temperature d/f between melting and crystallization point.
  4. Harmless to the environment.
  5. Low toxicity & Non-flammable
  6. Good stability for repeated phase change.
  7. Large thermal conductivity.
  8. Ease of availability & Low price
  
- ❑ Paraffin wax meets most of the mentioned properties, it is an excellent material for storing heat, with a heat of fusion of 200–220 J g<sup>-1</sup>.

# Design & Material Selection

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- ❑ Besides, the PCMs with a phase change temperature range from 18 °C to 35 °C is the most suitable for application in clothing.
- ❑ Selected materials is Paraffin wax (or petroleum wax), it is a soft colorless solid derived from petroleum, coal or shale oil.
- ❑ As this material meets most of the required parameters for textile usage.



**Fig. 10**

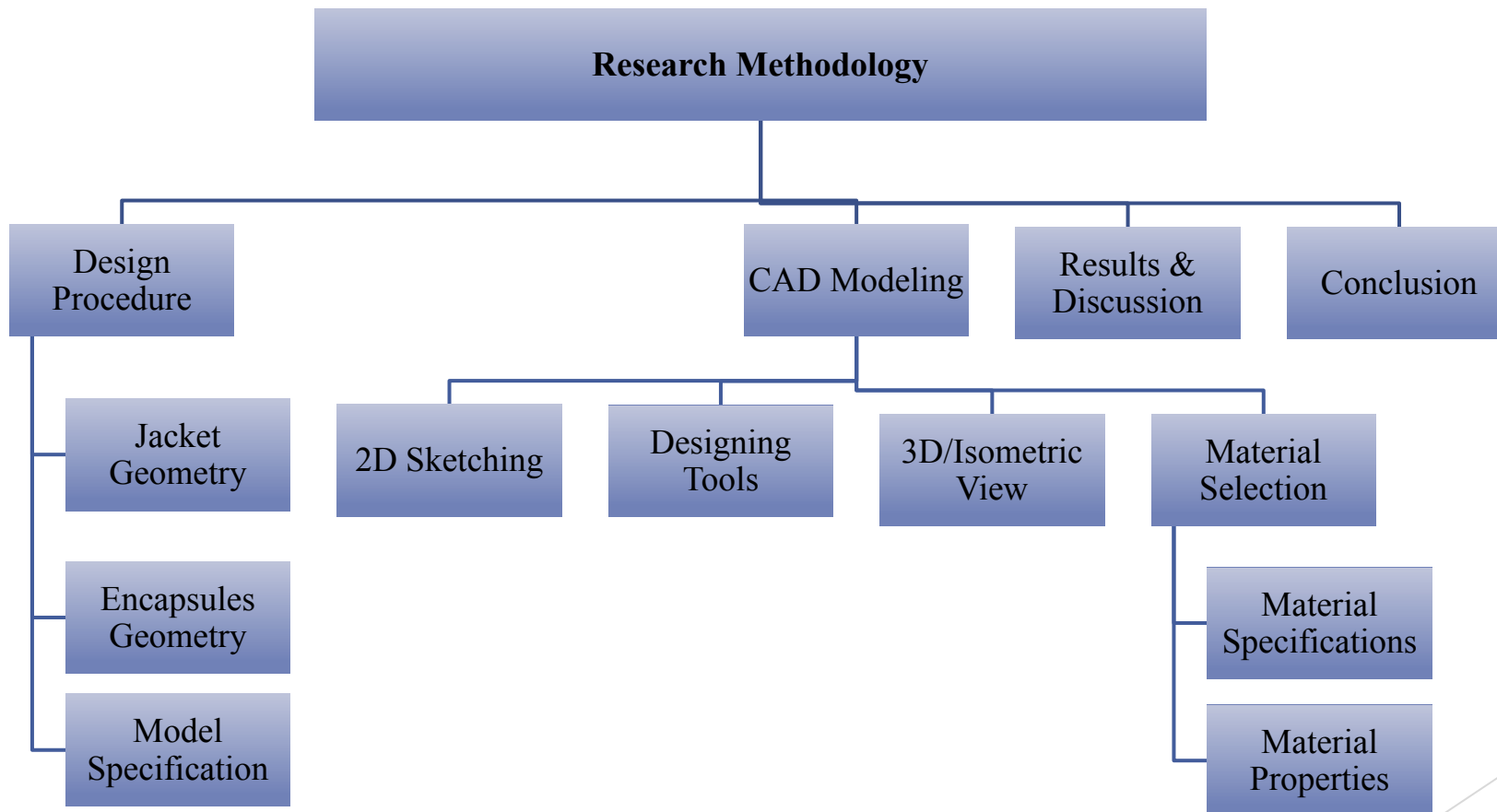


**Fig. 11**

# Methodology

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- The objectives involve **sketching of the jacket**, developing the **3D model** by adding the required material & finally **meshing & simulation** process to analysis **temperature fluctuations** among three layers. These can gain by following methodology.



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