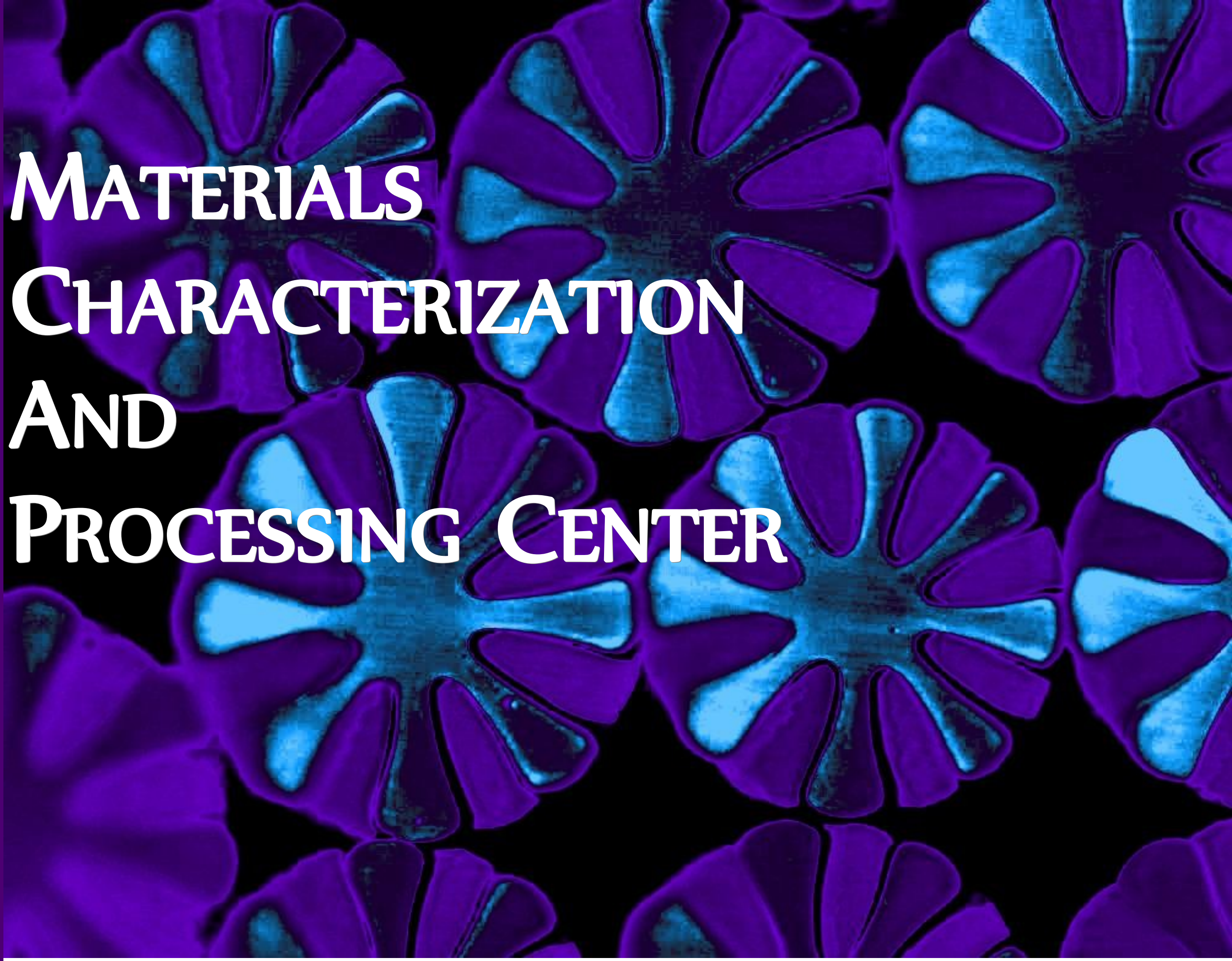

Materials Characterization And Processing Center

A group of highly dedicated and experienced professionals providing services including: Analytical and Physical Testing, Manufacturing, Spinning and Processing

MATERIALS SCIENCE & ENGINEERING
161 Sirrine Hall Clemson, SC 29634-0971
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Cover Image by Nicole Hoffman (2016 MSE MS graduate)
3rd place winning entry in the 2015 Clemson University "Science As Art " Competition

This image was captured using a HUVITZ microscope (50X magnification) with reflected light and it shows the cross section of bi-component fibers that were produced at Clemson through melt spinning. These micro-flower fibers are referred to as Tiger Lilies and they consist of two different polymers. Science is constantly evolving and these innovative fibers mimic nature to enhance their properties and allow for numerous futuristic applications. As nature continues to evolve, so do our fibers and fabrics in the textile industry.

Department of Materials Science & Engineering
College of Engineering Computing and Applied Sciences
161 Sirrine Hall Clemson, SC 29634-0971

Materials Characterization and Processing Center

In the Department of Materials Science and Engineering, we hold our industry connections in very high regard. Not only do we educate and train future materials professionals, but we also develop and utilize leading technology that advances the boundaries of the profession. Our laboratories serve the undergraduate and graduate students, in addition to the faculty of Materials Science and Engineering and we welcome opportunities to partner with Industry via various mechanisms.

As a department, we are able to offer the services of our Materials Characterization and Processing Center, which provides analytical and physical testing, manufacturing, fiber extrusion and processing support and services. These services are also available to others on campus on a departmental, college and university wide level.

A core component of our mission is to provide public service testing on a fee basis for Industry. Our Center is committed to thoughtful problem solving and analysis, a direct result of our in depth technical experience and extensive knowledge gained, in part, via collaborations with faculty and industry partners. We are especially skilled at establishing non-routine, unique protocols to assist with a variety of needs including troubleshooting, defect analysis, proof of concept and pilot scale testing and analysis.

Visit our home page at: www.clemson.edu/mse

For equipment lists and billing rates go to:

www.clemson.edu/cecas/departments/mse/pdf/Dept_Equipment_List_2016.pdf

www.clemson.edu/cecas/departments/mse/pdf/MSE%20Billing%20Rates%20FY%2019%20website.pdf

Materials Characterization Instrumentation

Thermal analysis

FTIR (Infrared Spectroscopy)

Chromatography

Gas (GC)

Liquid (LC)

Supercritical Fluid (SFC)

ASE (Accelerated Solvent Extraction)

Four Common Thermo-Analytical Techniques

DSC (Differential Scanning Calorimetry)

Measures changes of heat flow into and out of a sample

TGA (Thermo-Gravimetric Analysis)

Measures changes in sample mass

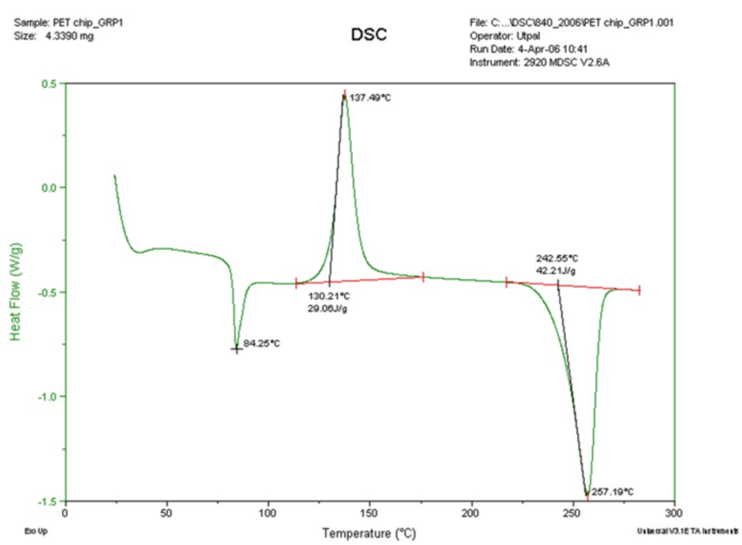
TMA (Thermo-Mechanical Analysis)

Measures changes in the dimensions of a sample

DMA (Dynamic Mechanical Analysis)

Measures changes in the mechanical properties of a sample

Example polyester DSC showing the three expected thermal transitions for un-crystallized PET



Thermal Analysis

Four Common Thermo-Analytical Techniques

DSC (Differential Scanning Calorimetry)

Measures changes of heat flow into and out of a sample

➡ TGA (Thermo-Gravimetric Analysis)

Measures changes in sample mass

TMA (Thermo-Mechanical Analysis)

Measures changes in the dimensions of a sample

DMA (Dynamic Mechanical Analysis)

Measures changes in the mechanical properties of a sample

Most Common Applications of Thermo-Analytical Techniques

Determination of the glass transition temperature, T_g

Determination of the melting point, T_{mp}

Measuring % crystallinity using the heat of melting ΔH_{mp}

Characterizing the thermal (heat exposure) history, especially the heat set temperature.

FTIR (Infrared Spectroscopy)

Thermal analysis

FTIR (Infrared Spectroscopy)

Chromatography

- Gas (GC)
- Liquid (LC)

ASE (Accelerated Solvent Extraction)

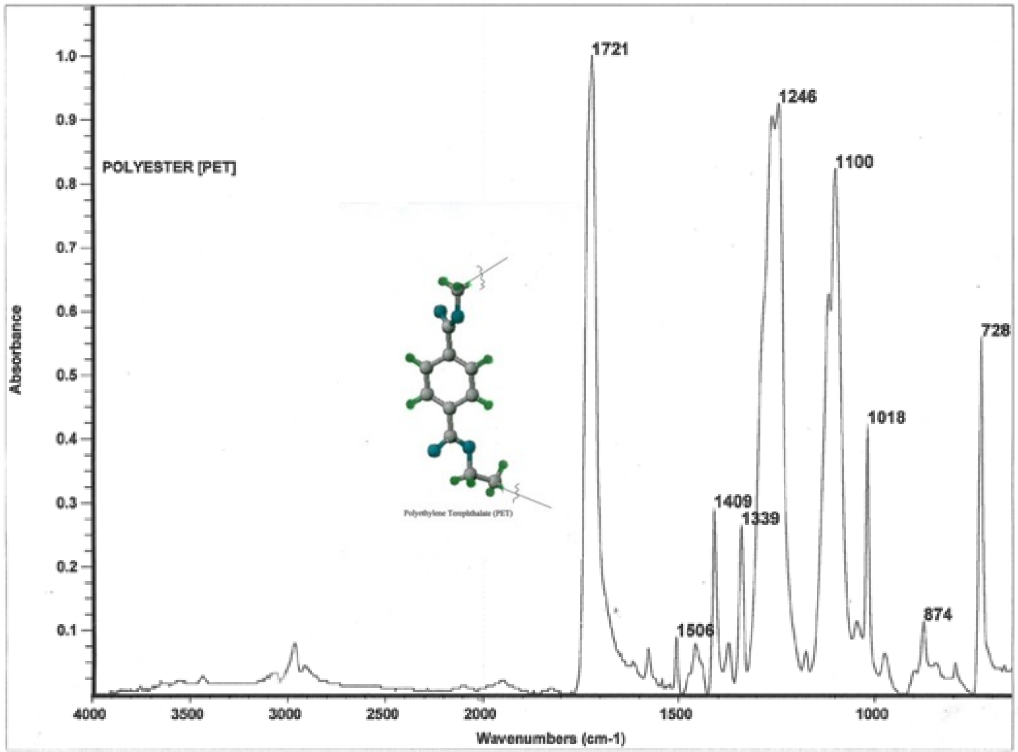
Thermo-Nicolet Magna 550 FTIR

FTIR (Infrared Spectroscopy)

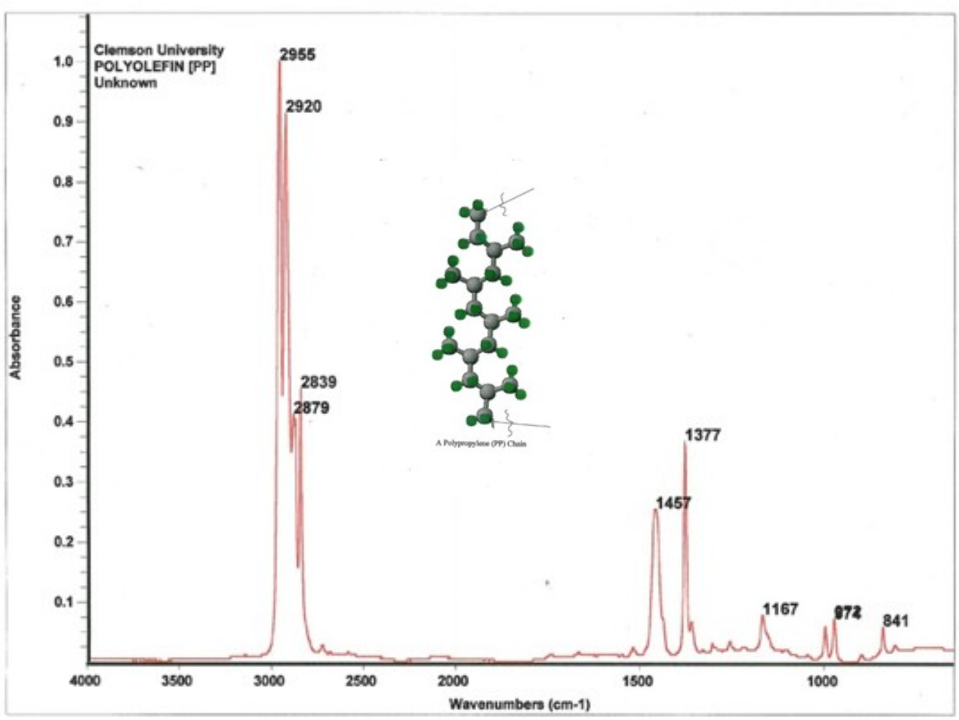
FTIR Sampling Techniques

- Nic-Plan FTIR Microscopy
- Micro-ATR
- Diamond ATR
- DRIFT
- Grazing angle

IR Spectra of Polyester [PET]



IR Spectra of Polypropylene [PP]



Chromatography

Thermal analysis

FTIR (Infrared Spectroscopy)

➡ Chromatography

- Gas (GC)
- Liquid (HPLC (GPC))

ASE (Accelerated Solvent Extraction)

Waters GPC with RI, UV/Vis & PLabs ELSD

Chromatography

Selerity Series 4000 SFC
Supercritical Fluid Chromatography

Thermo-Finnigan Trace GC/MS Gas
Chromatography Mass Spectroscopy

ASE (Accelerated Solvent Extraction)

Thermal analysis

FTIR (Infrared Spectroscopy)

Chromatography

- Gas (GC)
- Liquid (LC)

Supercritical Fluid (SFC)

ASE (Accelerated Solvent Extraction)

Dionex ASE Accelerated Solvent Extraction

Physical Evaluation Facility
Room 274/280—Sirrine Hall

Numerous testing instruments are available with capabilities of gathering computer generated data along with a Microscope facility (Room 280) housing Image Analyses systems, Birefringence, and Stereo Microscopes. The Laboratory uses various published "Standards" such as American Society Testing & Materials (ASTM), Federal Test Methods (FTM), American Association of Textile Colorists & Chemists (AATCC) as well as "Standards" written by individuals and companies to accomplish the testing required. This assures compatibility and repeatability between tests and other facilities.

For further information call (864) 656-5972 or fax to:
(864) 656-5973 or email Dr. Kate Stevens ksteven@clemson.edu.

For equipment lists and billing rates go to:

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Physical Testing Support/Services

Dr. Kate Stevens, Technical Services Manager

(864) 656-5972 or Fax to (864) 656-5973

ksteven@clemson.edu

Physical Testing Facility Instrumentation

Instron Models 5500R1125 and 4582:

Provide fiber, yarn and fabric characterization. Load Cell capacities range from 10 (g) to 22,000 (lb), providing the ability to test a wide variety of materials. The data gathered from testing is computer generated (Bluehill 2 Software). A stress/strain curve along with data points and printed graphs are available.

Instron Models 5500R1125 and 4582

Uster Tester 4

Utilizes the principle of electrical capacitance to measure the mass variations of slivers, rovings and yarn. The most important quality parameters such as evenness and yarn imperfections with high precision at 400 yd./min. enables reproducible measurements. The CV% is a number used to describe the overall uniformity of a tested material and is a very strong indicator of quality. CV (coefficient of variation) is a numerical value that shows the amount of variation around the mean mass of a tested material.

Uster Tester 4

Capillary Flow Porometer

(CFP-1100-AEXS): Test results are used to determine the Gas permeability, mean flow pore size, bubble point, pore size distribution of all porous materials including Nonwovens, and Textiles. The instrument is used primarily for determination of the pore structures in the tested materials. The CFP is recognized as one of the most reliable instruments in determining the above measurements.

Capillary Flow Porometer

Capillary Flow Porometer

Optical Microscopy and Image Analyses

Leitz Laborlux R/T Microscope with lightfield and darkfield viewing capabilities, Meiji Techno RZ Microscope - Magnification ranges are 7.5 X to 500X , Sony Digital Camera Model 90 attached along with Image Pro Plus software for collection of measurements (fiber diameter, cross-sectional areas, etc.). A Sony Color Video printer for instant capture and sample printing is also available.

Leitz Laborlux R/T Microscope

For equipment lists and billing rates go to:

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Padder and Ernst Benz Oven

Utilized for Industrial comparisons of Latex trials. Percentages of Latex are applied to Nonwoven materials, dried in Benz Oven. Maximum width – 15”.

Padder and Ernst Benz Oven

Atlas Fadeometer

Utilizes Carbon Arc Lamp, Continuous Light - Samples are subjected to requested hours within the testing chamber, evaluated for colorfastness (color change) whether in hue, chroma or lightness. LAB values are collected utilizing the Gretag Macbeth Color i 5 Spectrophotometer.

Atlas Fadeometer

Atlas Launderometer

Accelerated laundering tests used to evaluate the colorfastness to laundering of materials which are expected to withstand frequent laundering. The fabric color loss and surface changes resulting from detergent solution and abrasive action of five typical hand, home or commercial launderings, with or without chlorine, are simulated by one 45 minute test.

Atlas Launderometer

For equipment lists and billing rates go to:

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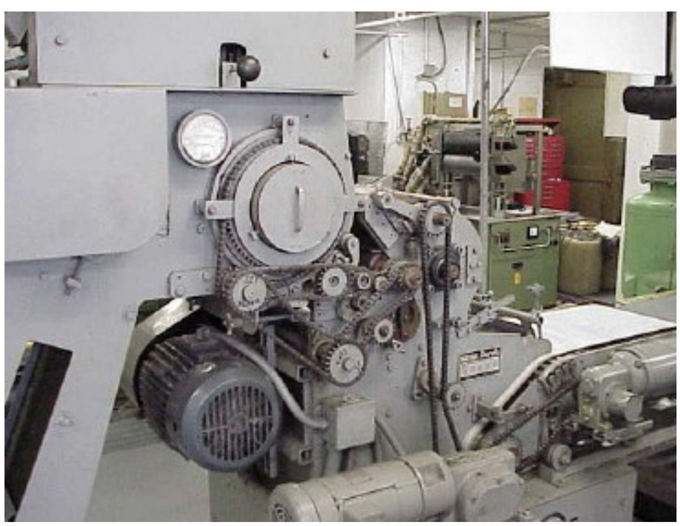
Web-Forming Processes

Air-Laid Web Forming

The Rando Webber produces an air laid web that is isotropically layered with a width of 12 inches. The conveyor system can provide web drafting before bonding.

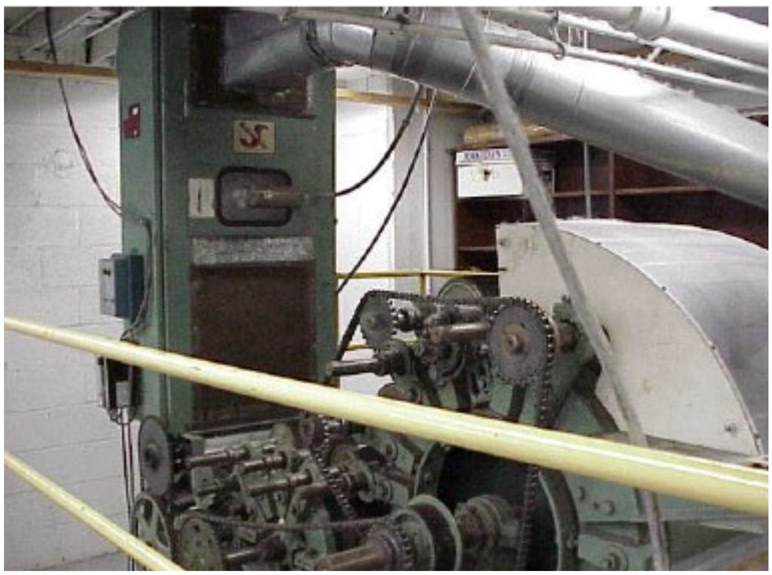


Rando Webber

Carding

Proctor and Schwartz Felt Maker’s Card

The process starts with an opening/chute system that feeds the fiber to the feed roll and then onto the lickerin of the machine. From there, the fiber is fed into the card where 5 different sets of worker/stripper roll combinations mix and align the fiber. Drafting within the card is also very controllable as almost every roll has its own motor with adjustable speed.



Proctor and Schwartz Felt Maker’s Card

Befama Card and Cross Lapping

This line has a Rando opener which feeds the fiber into a chute system which then feeds the 20 inch Befama Card. From the card, the formed web is fed onto a 24 inch Automatex cross lapper conveyor system.

Befama Card

Cross-Lapping

Bonding Processes

The bonding procedures possible include needlepunching, thermal bonding, hydro-entanglement, calendaring, print bonding, ultrasonic bonding and thru-air bonding. Any type of fiber that has the length between 1in and 3in, and has the maximum denier of 30 may be formed as nonwoven fabric.

Continuous Needle Punch Line

This line has a Rando opener which feeds the fiber into a chute system which then feeds the 20 inch Befama Card. From the card, the formed web is fed onto a 24 inch Automatex cross lapper conveyor system. The bonding is completed by an Automatex Needle Loom which is 27 inches wide and contains 1376 needles.

Continuous Needle Punch Line

Hydroentanglement

The water is pumped from its reservoir through a filtration system to the manifold. The high pressure forces the water out of the jet head and onto the conveyor screen where a vacuum system underneath helps to pull the water through the web. The maximum water pressure in this lab is roughly 1000psi.

Hydroentanglement

Sonic Bonding

The Sub-basement also has a 9 inch James Hunter Pin-Sonic Bonder. The pin sonic machine will vibrate at a very high frequency and generate heat from the sound it makes. The heat generated will fuse thermoplastic fibers together to make a very strong bond. The machine vibrates at a frequency of 20 kHz.

Sonic Bonding

Calendaring

The fiber is formed into a web and fed onto a conveyor system to carry the material onto a set of oil heated calendar rolls for bonding. With little modification, the calendar rolls can be changed so that both point and area bonding are possible. The speed and the pressure of the rolls can easily be changed. Calendar roll maximum temperature is 140ºC and maximum pressure between the rolls is 50psi.

Calendaring

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