Team 19

CNT Reinforced Ceramics 3D Printer

Midterm Presentation

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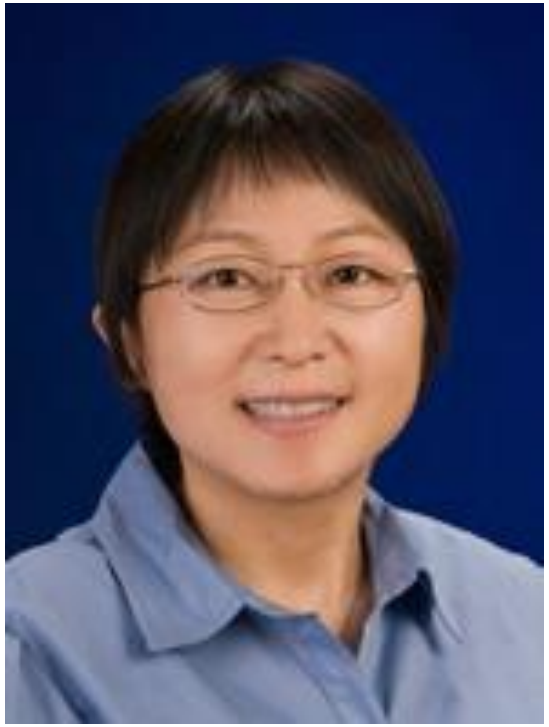
Presentation Contents

- Our Advisor
- Project Definition
- Customer Specifications
- Materials Selection
- Design Concepts
- Potential Challenges and Risks
- Gantt Chart
- Future Plans
- Summary

Dr. Cheryl Xu



- Project Sponsor and Advisor
- Associate Professor at the COE
- Ph.D. in Mechanical Engineering from Purdue University, 2006
- Major Research Interests involve manufacturing process optimization and control, high temperature sensor design, and manufacturing of advanced materials

Project Definition

Design and construct a 3D Printer capable of printing and curing Carbon Nanotube (CNT) Reinforced Ceramic Polymer Composites such that the CNT's in the ceramic matrix are at a maximum concentration and are aligned parallel to the printing platform

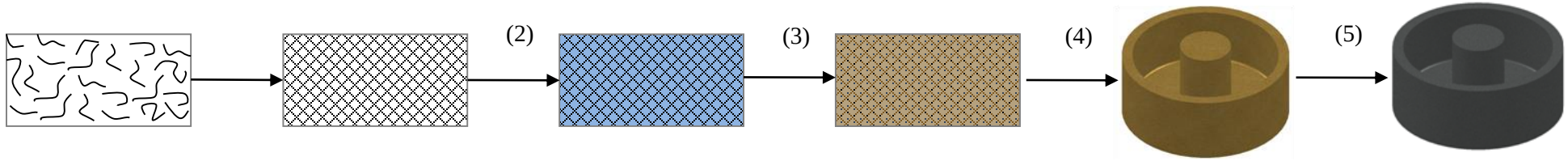


Figure 1: Schematic showing the basic steps for making ceramic matrix composites (Multifunctional Ceramic Matrix)

Customer Specifications

- Use of multi-walled CNT to minimize costs
- Print Envelope: Minimum 3 x 3 x 3 inches
- Alignment Method: Electric Field Induced Alignment
- Onboard Interface: Start/Emergency Stop Buttons, LCD Display, Directional Keypad
- Control Hardware: Temperature Sensor Package,
- Print Head Position Monitoring,
- Microcontroller

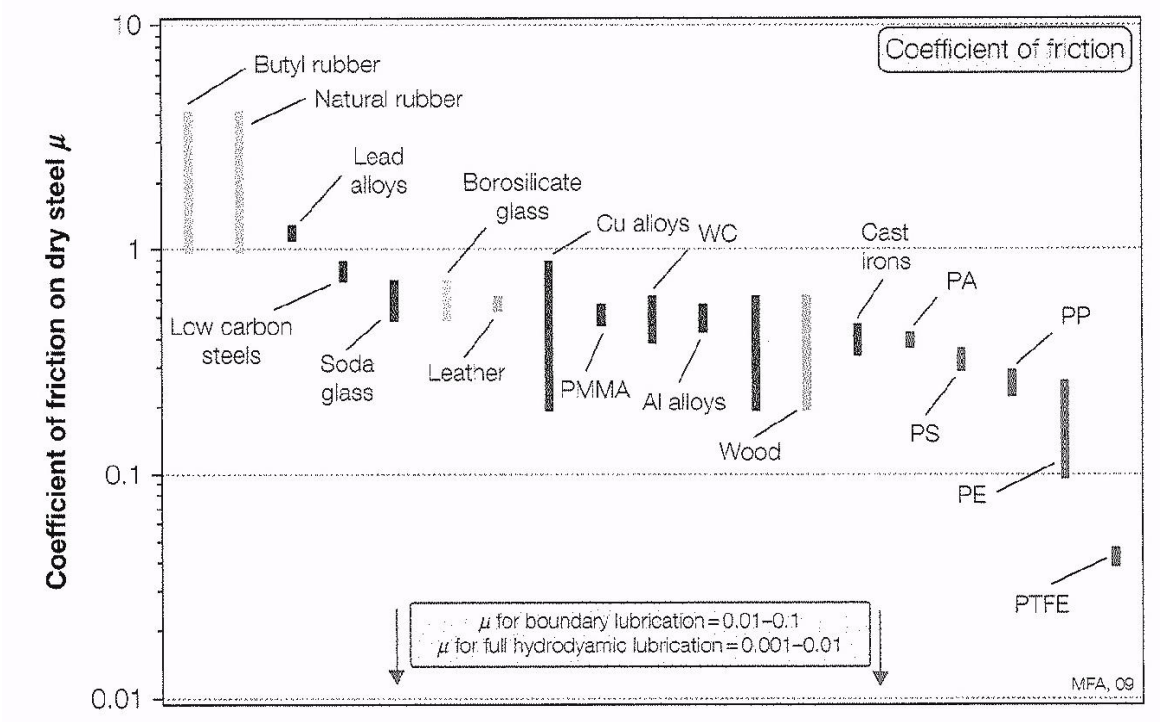
Materials Selection

Build Chamber Insulation

- Minimize thermal heat transfer
- Fourier's Law $$Q = -kA\frac{dT}{dx}$$

Extruder Head

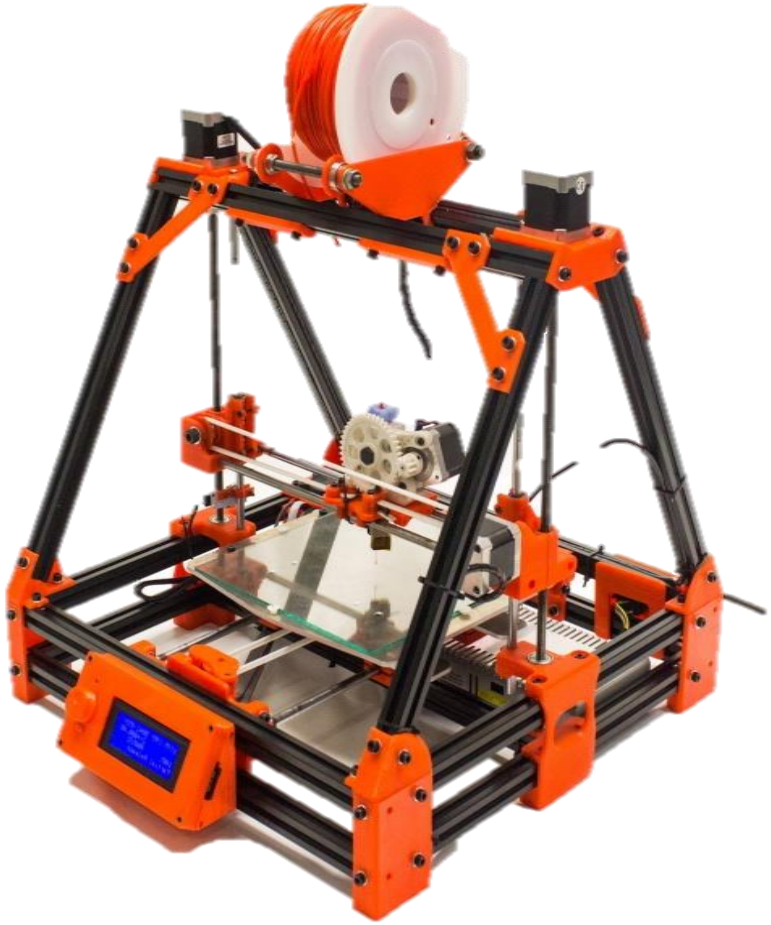
- Low coefficient of friction
- Teflon best material based on Ashby Plots



The coefficient μ of materials sliding on an un-lubricated steel plate

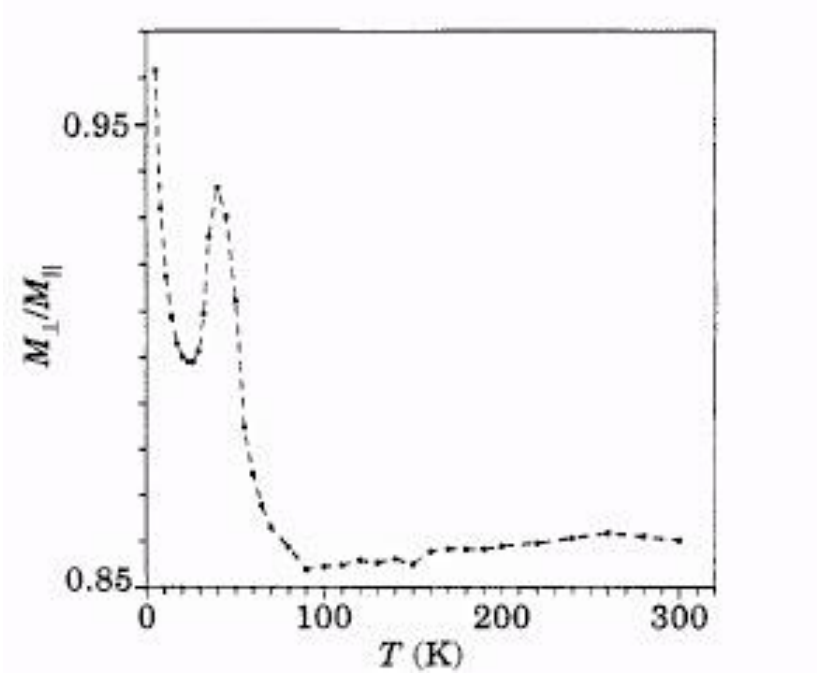
Design Concepts

- Carbon nanotube alignment
  - Electromagnetic Field
- Curing method
- Heat vs. Ultraviolet
- Overall 3D printer
  - Retrofit an existing product
  - Design a new printer



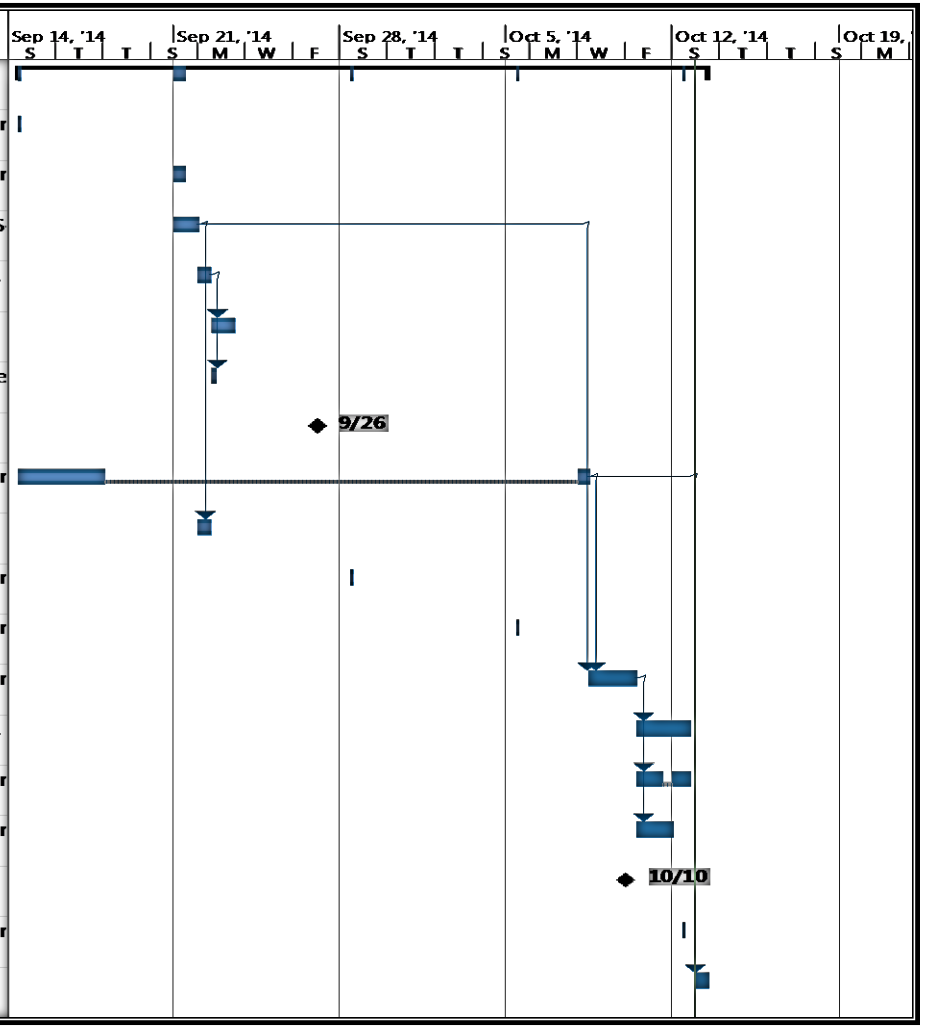
Potential Challenges and Risks

- Temperature range for alignment v. curing
- Uniform dispersion of reinforcing CNT
- Difficult to achieve with conventional powder-metallurgy based ceramic techniques
- Maximize density of CNT while minimizing imperfections
- No more than 5-10% of total CNT damaged or misaligned
- Pyrolysis results in volume reduction of approximately 60%



Gantt Chart

ID	Task Mode	Task Name	Duration	Start	Finish	Prede	Resource Names
6		**Define**	**26.7 days**	**Sun 9/14/14**	**Mon 10/13/14**	**2**	
7	✓	Group Meeting 1	2 hrs	Sun 9/14/14	Sun 9/14/14		Basak Simal,Cody Evar
8	✓	Group Meeting 2	2 hrs	Sun 9/21/14	Sun 9/21/14		Basak Simal,Cody Evar
9	✓	Conduct Needs Assesment	0.8 days	Sun 9/21/14	Sun 9/21/14		Basak Simal,Daphne S
10	✓	Research Competition Rules	4 hrs	Mon 9/22/14	Mon 9/22/14		Cody Evans,Sam Yang, Basak Simal
11	✓	Assess Competition Viability	0.8 days	Mon 9/22/14	Tue 9/23/14	10	Basak Simal,Cody Evans,Daphne
12	✓	VentureWell Application	3 hrs	Mon 9/22/1	Mon 9/22/14	10	Cody Evans,Ernest Etie
13	✓	Needs Assessment Deliverable	0 hrs	Fri 9/26/14	Fri 9/26/14		Basak Simal
14	✓	Meet with Sponsor	38 hrs	Sun 9/14/14	Wed 10/8/14		Basak Simal,Cody Evar
15	✓	Draft Technical Questionnaire	4 hrs	Mon 9/22/14	Mon 9/22/14	9	Cody Evans
16	✓	Group Meeting 3	2 hrs	Sun 9/28/14	Sun 9/28/14		Basak Simal,Cody Evar
17	✓	Group Meeting 4	2 hrs	Sun 10/5/14	Sun 10/5/14		Basak Simal,Cody Evar
18		Analyze VOC	1.6 days	Wed 10/8/1	Fri 10/10/14	9,14	Basak Simal,Cody Evar
19		Draft Product Specifications	2.4 days	Fri 10/10/14	Sun 10/12/14	18	Sam Yang,Cody Evans,
20		Update Needs Assessment	1.6 days	Fri 10/10/14	Sun 10/12/14	18	Basak Simal,Cody Evar
21		Update Code of Conduct	1.6 days	Fri 10/10/14	Sat 10/11/14	18	Basak Simal,Cody Evar
22		Submit Project Spec Report	0 days	Fri 10/10/14	Fri 10/10/14		Basak Simal
23		Group Meeting 5	2 hrs	Sun 10/12/1	Sun 10/12/14		Basak Simal,Cody Evar
24		Meet with Matl. Expert Jinshan	3 hrs	Mon 10/13/14	Mon 10/13/14	14	Ernest Etienne



Future Plans

- Research
- Examine blue prints
- Define BOM
- Design prototype
- Additional meetings with advisors and co-sponsors
- Finish preliminary design

In Summary

- Discussed project scope and definition
- Discussed costumer requirements
- Introduced possible materials
- Introduced potential ideas

- Upcoming weeks:
  - Define working temperatures
  - Set material parameters
  - Work on tooling and material options

References

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7. Xu, Chengying. “Multifunctional Ceramic Matrix Nanocomposites Manufacturing”. (Word Document) < http://materials.fsu.edu/9-New-Faculty-Members-Joining-Materials-Science-Engineering#Xu>.

Questions?