Electron Beam Pretreatment of Lignocellulosic Biomass

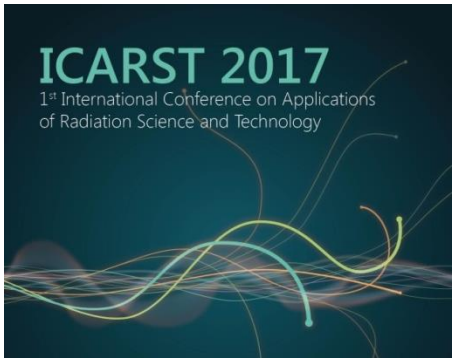
Mark Driscoll[1], Arthur Stipanovic[1], Dianne Poster[2], Michael Postek[2], Mohamad Al-Sheikly[3] and Jay LaVerne[4]

[1] SUNY College of Environmental Science and Forestry

[2] U.S. National Institute for Standards and Technology

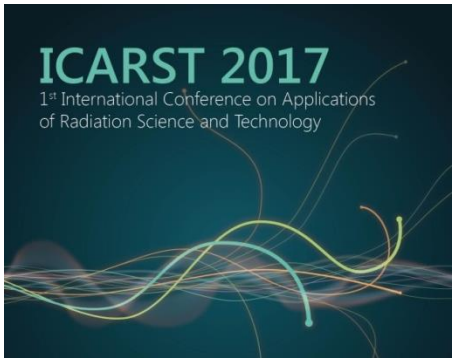
[3] University of Maryland, College Park

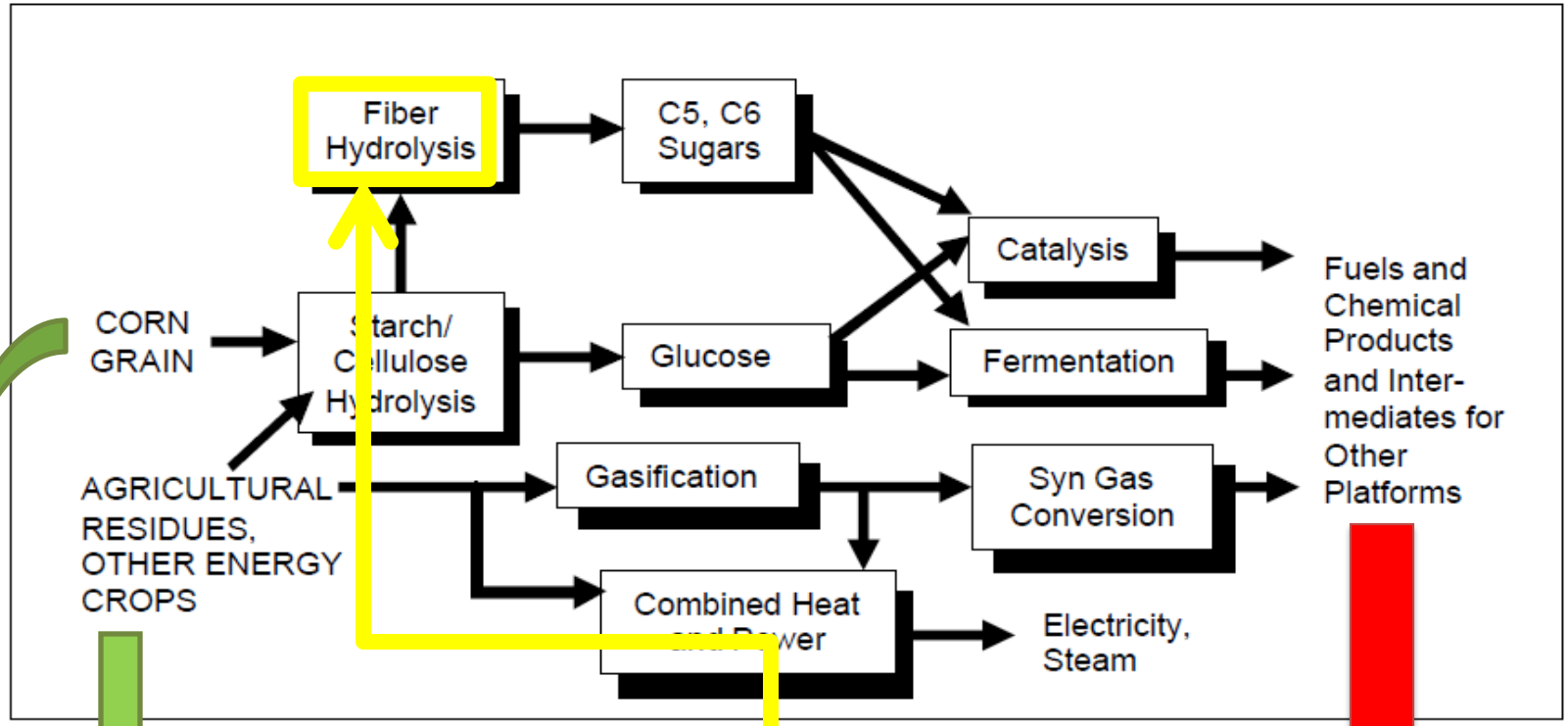
[4] University of Notre Dame



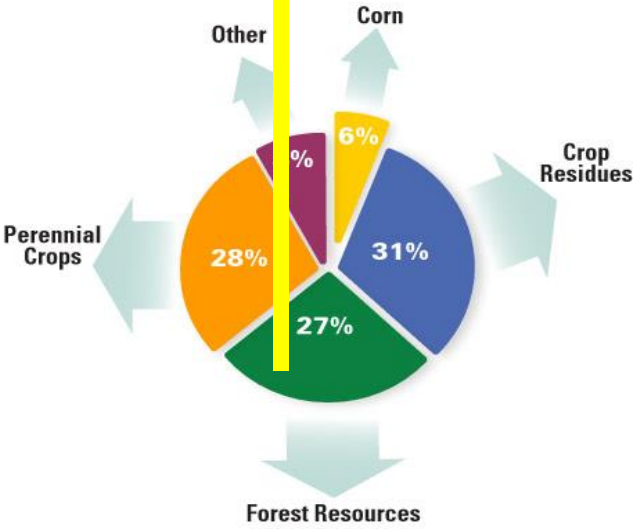
Lignocellulosic Materials

- Biomass crops
  - Switchgrass
  - Elephant grass
- Agriculture residues
  - Corn stover
  - Straw
- Wood





Biomass



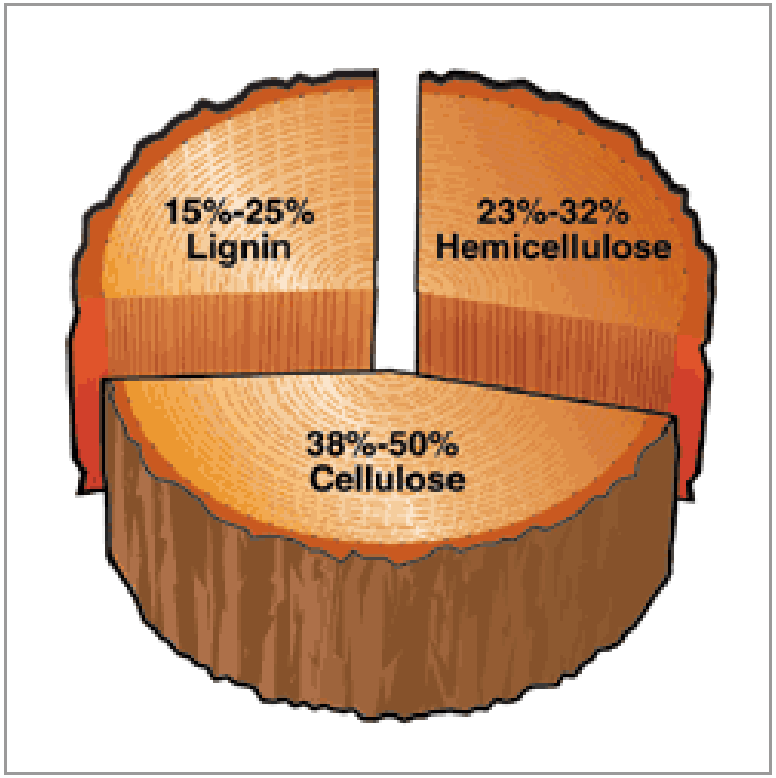
Projected U.S. Biofuel Sources
Source: Biomass as Feedstock for a Bioenergy and Bioproducts Industry: Technical Feasibility of a Billion Ton Annual Supply. 2005. DOE and USDA.

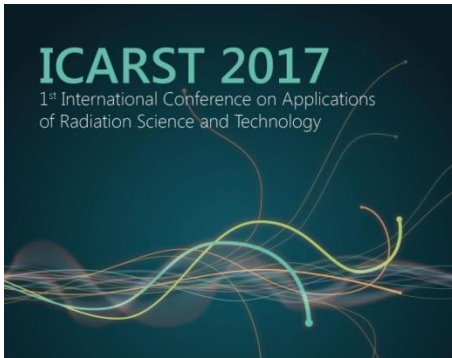
Biofuels Biomaterials

Ref: Industrial Bioproducts: Today and Tomorrow. ***2003***

Wood

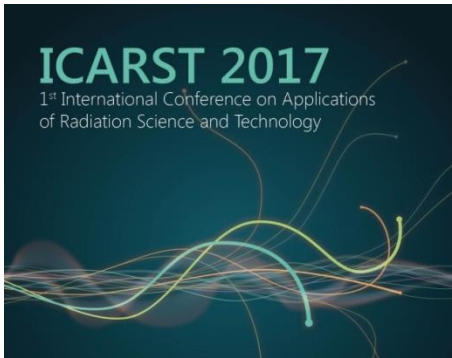
- **What is the macro composition of dry wood?**



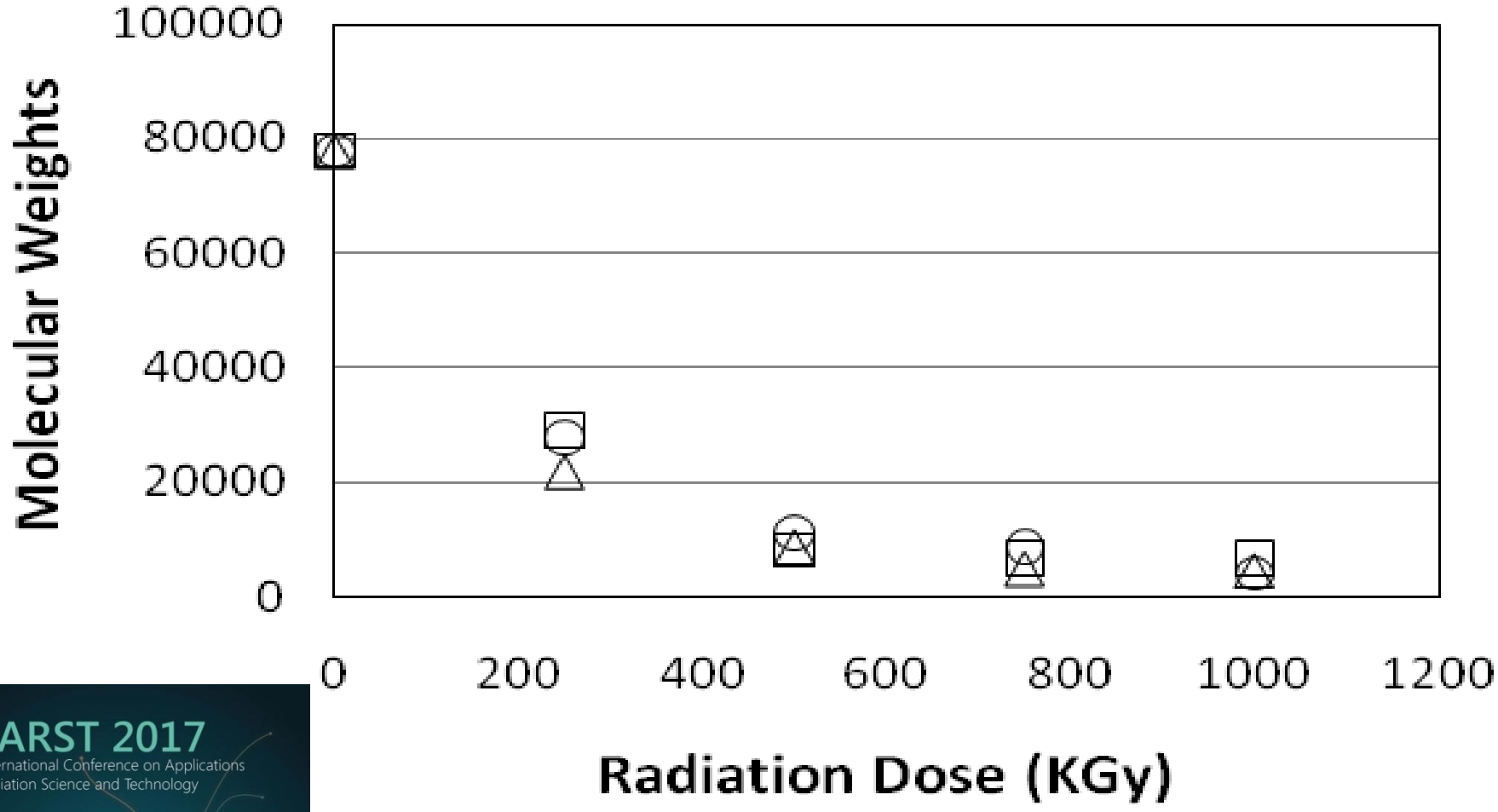


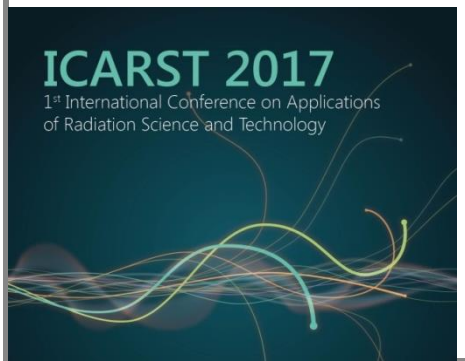
Irradiation

- IBA Industrial, Edgewood, New York, USA
- 90 kW, 3 MeV Dynamitron
- Wood was hard maple (*Acer saccharum*)
- Microcrystalline cellulose (MCC)
- Most samples 0.5cm thick or (<0.6g/cm^3) thus within equal-In equal out thickness
- Solid wood boards were 2.5 cm thick were irradiated on both sides to give a uniform dose

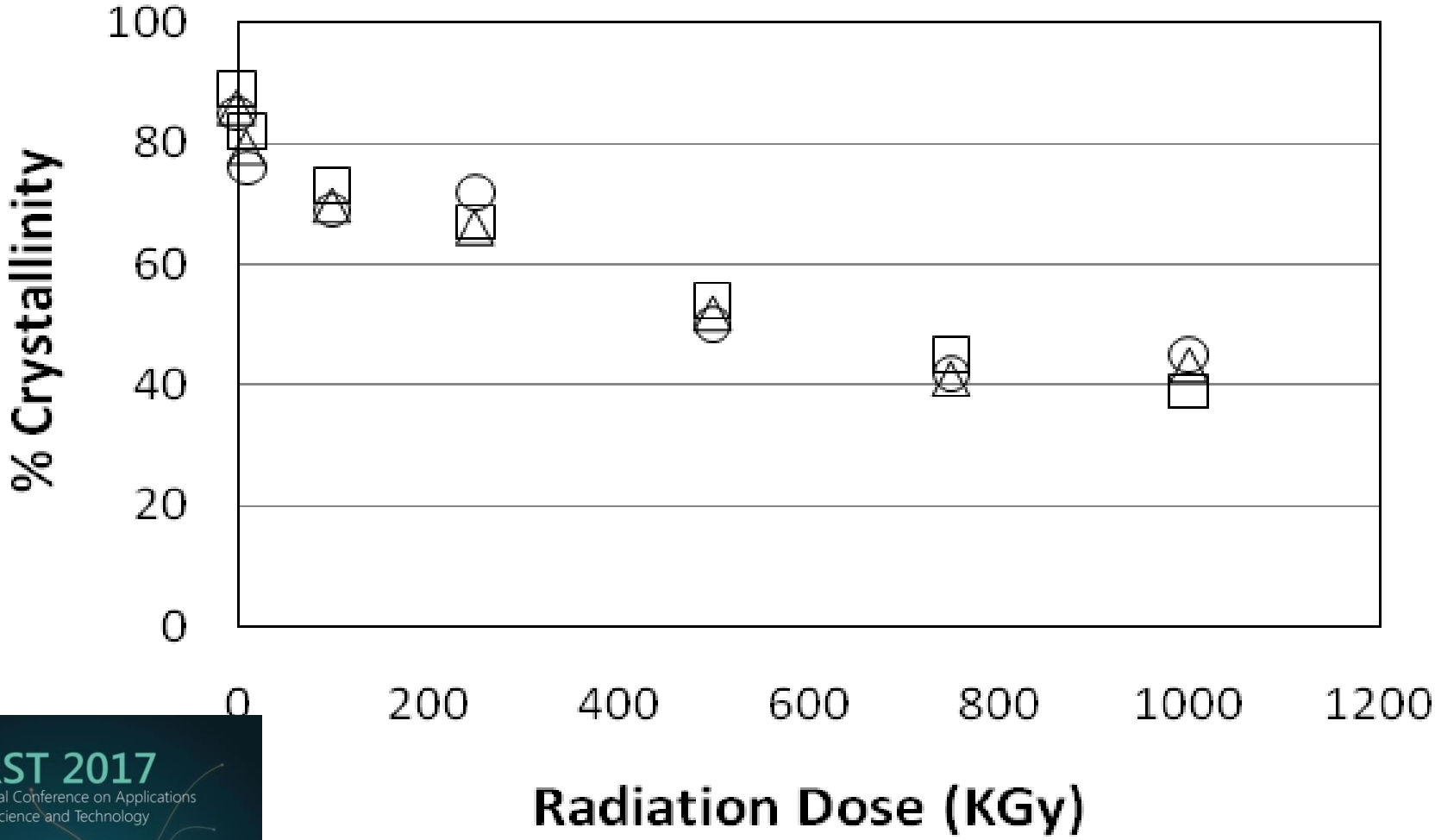


Effect of Radiation on Molecular Weight of MCC

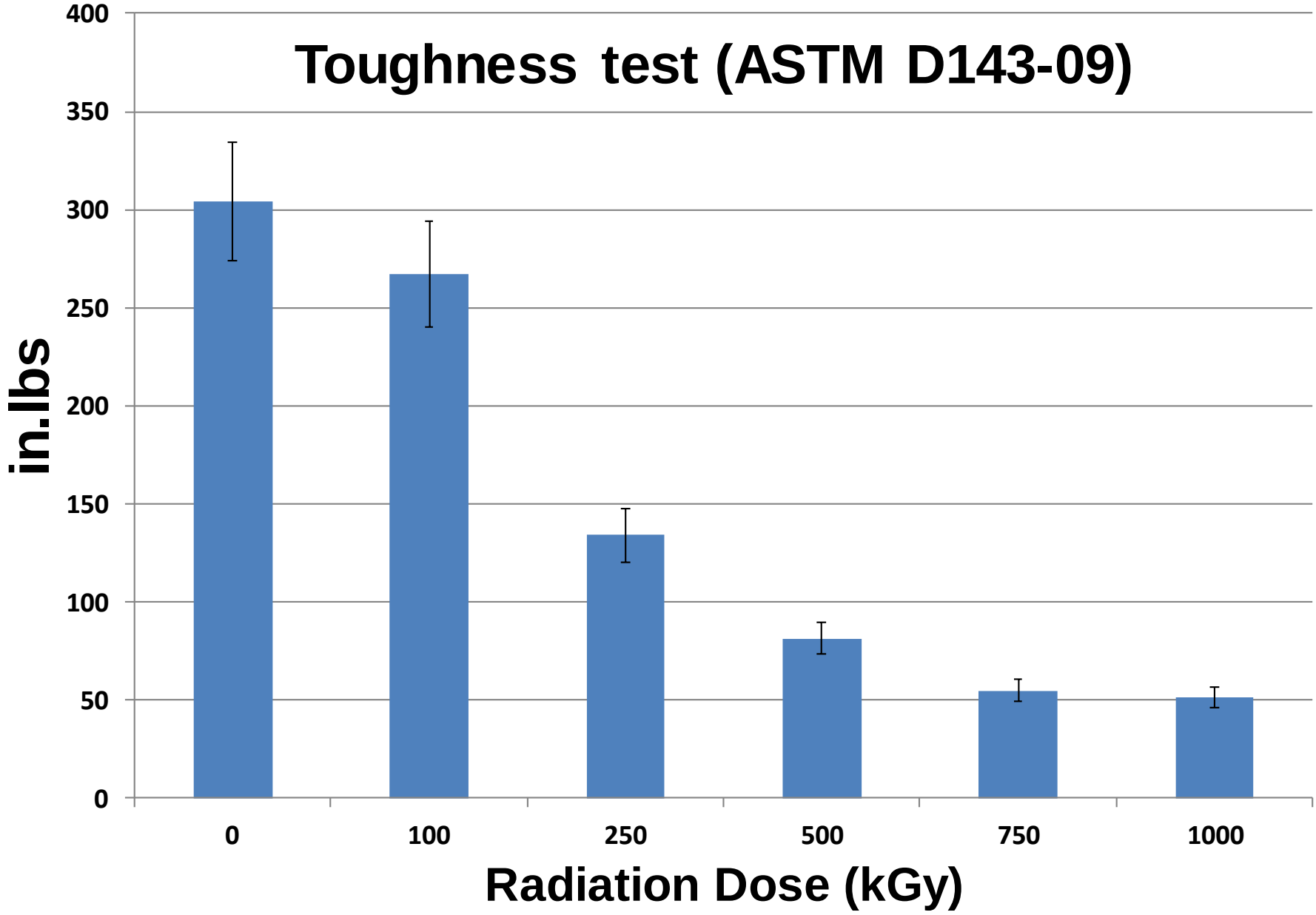




Effect of Radiation on Crystallinity (CP/MAS of MCC)

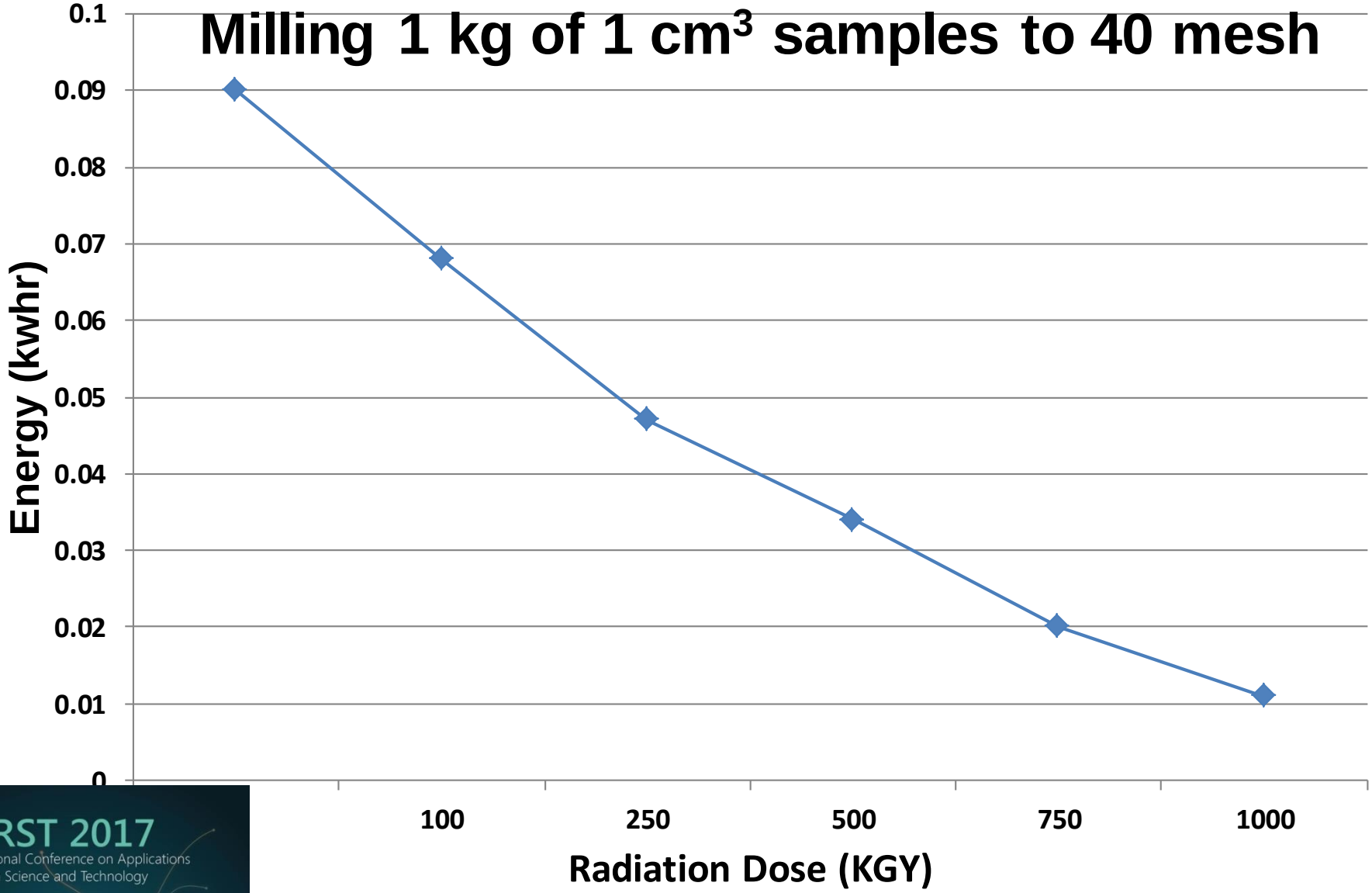


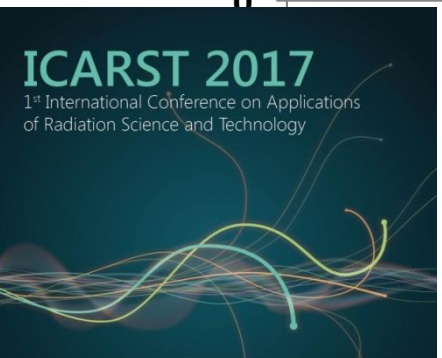
ICARST 2017
1st International Conference on Applications of Radiation Science and Technology

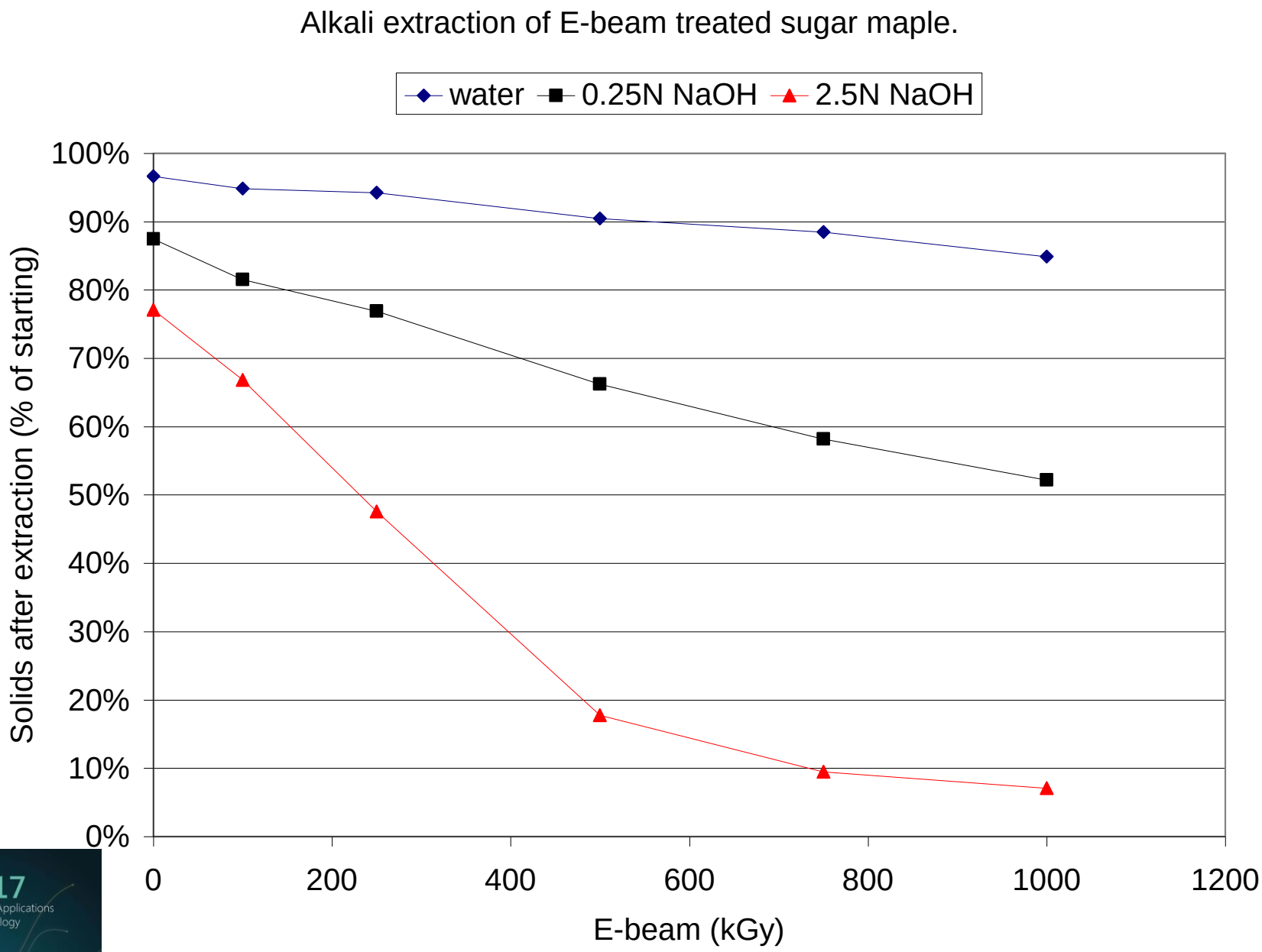

Toughness test (ASTM D143-09)
in.lbs
400
350
300
250
200
150
100
50
0
0
100
250
500
750
1000
Radiation Dose (kGy)

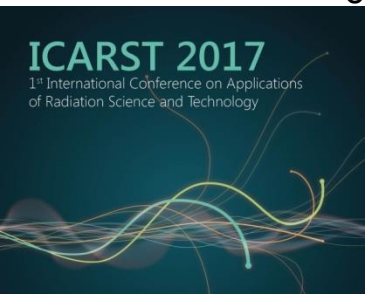
ICARST 2017

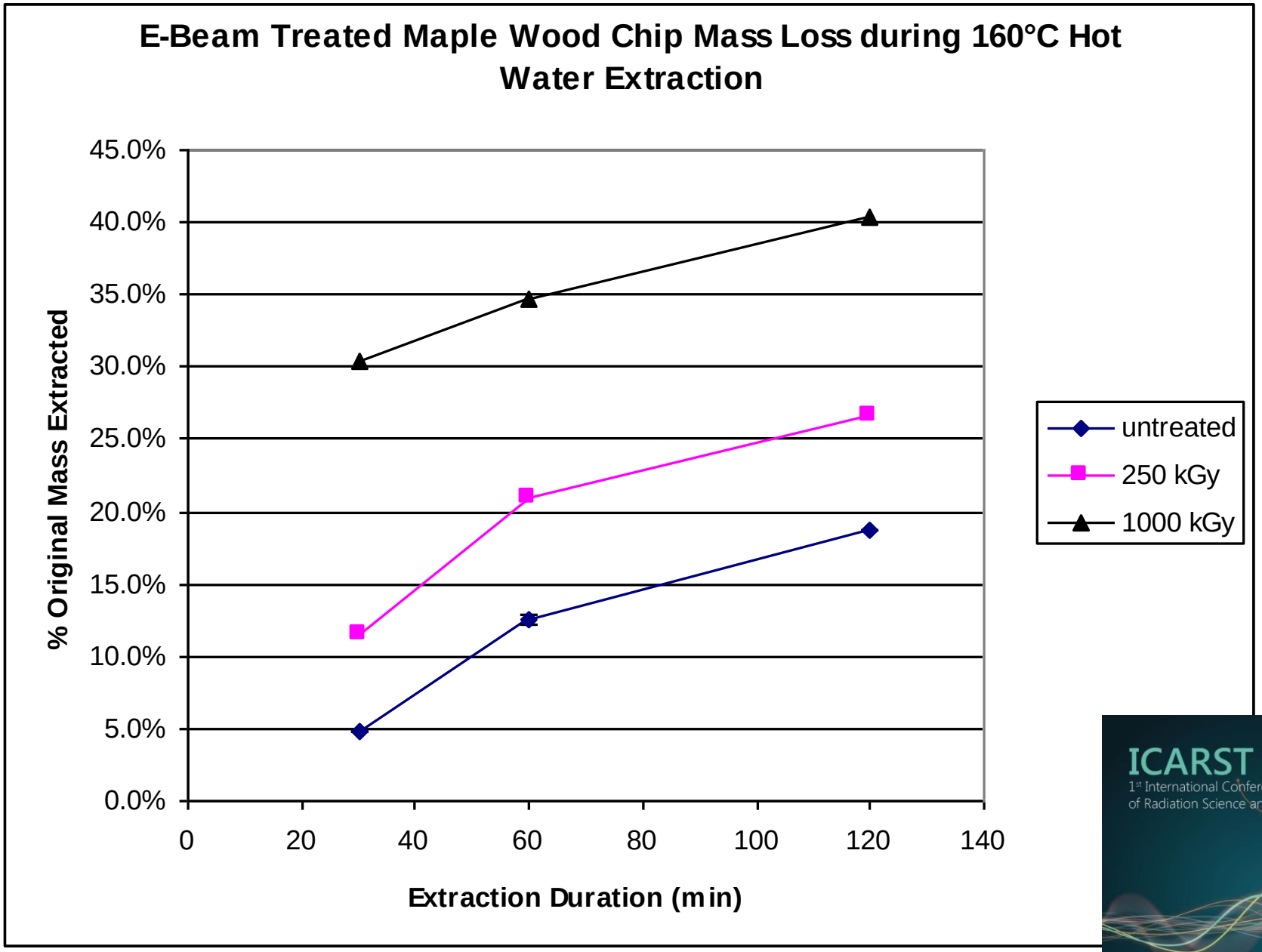
1st International Conference on Applications of Radiation Science and Technology

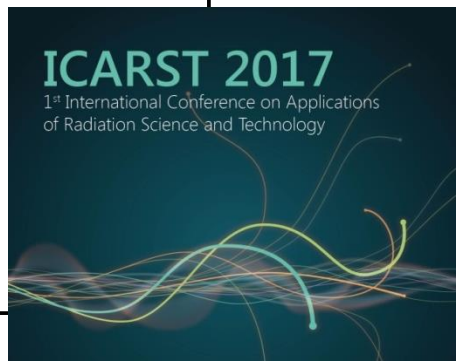

Milling 1 kg of 1 cm3 samples to 40 mesh
Energy (kwhr)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
100
250
500
750
1000
Radiation Dose (KGY)


ICARST 2017
1st International Conference on Applications of Radiation Science and Technology

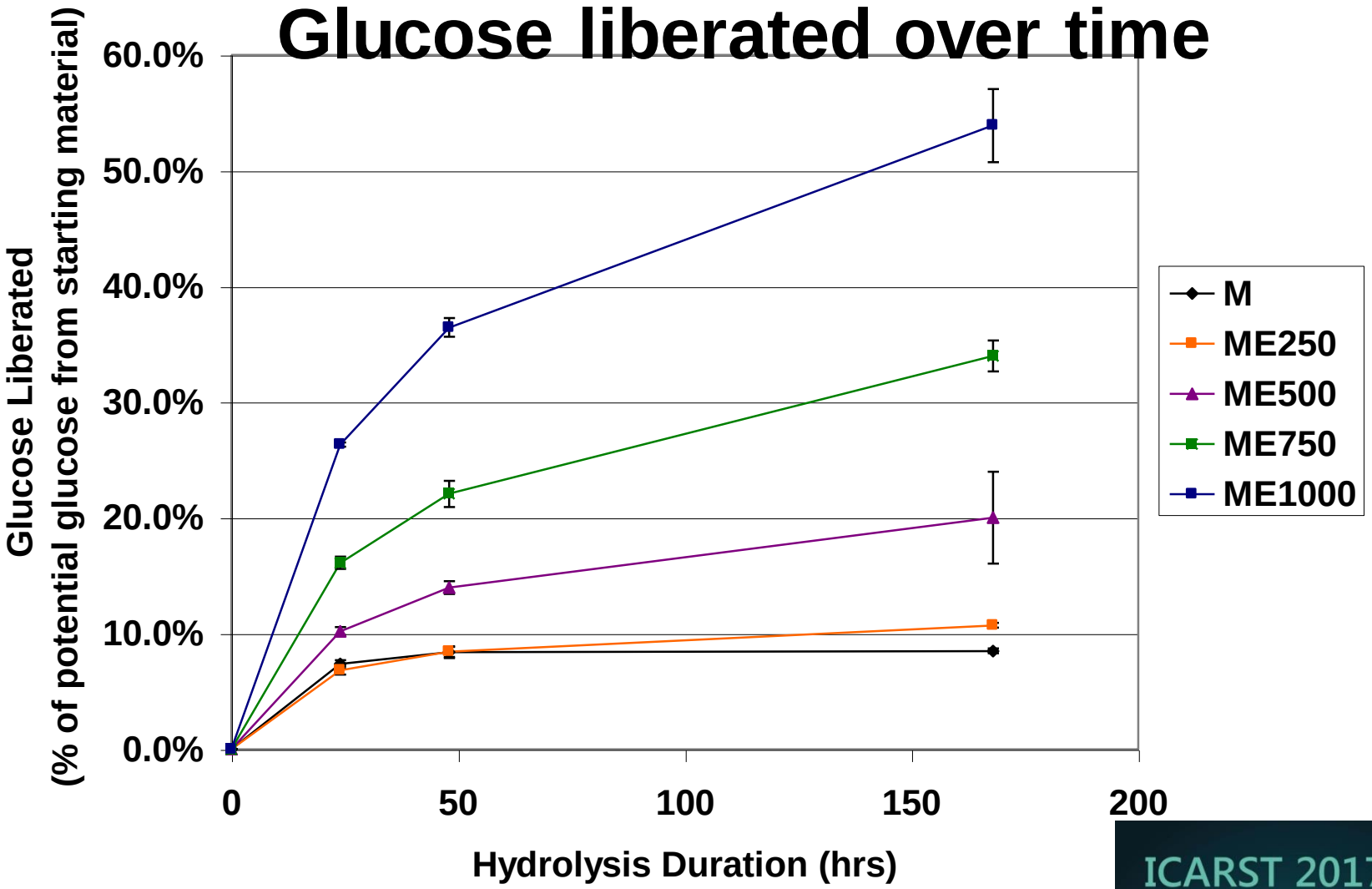

Alkali extraction of E-beam treated sugar maple.
water
0.25N NaOH
2.5N NaOH
Solids after extraction (% of starting)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
200
400
600
800
1000
1200
E-beam (kGy)

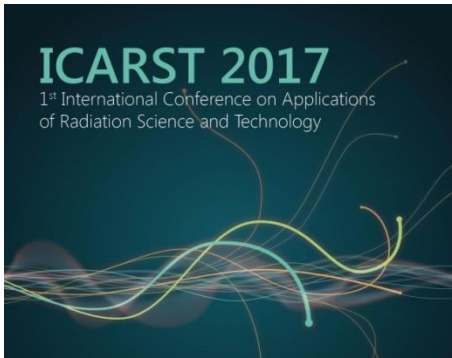

ICARST 2017
1st International Conference on Applications of Radiation Science and Technology


E-Beam Treated Maple Wood Chip Mass Loss during 160°C Hot Water Extraction
% Original Mass Extracted
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0
20
40
60
80
100
120
140
Extraction Duration (min)
untreated
250 kGy
1000 kGy


ICARST 2017
1st International Conference on Applications of Radiation Science and Technology

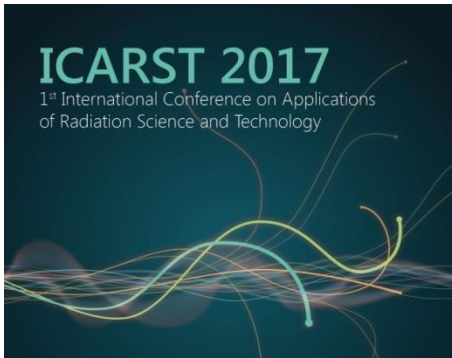
Glucose liberated over time





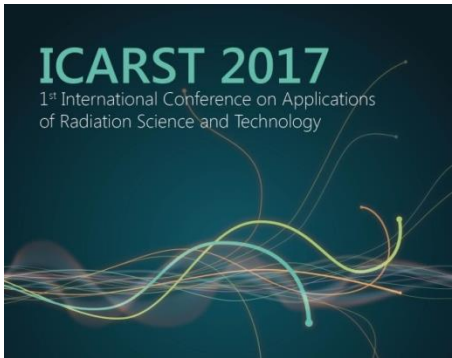
Irradiation

- **Electron beam irradiation**
  - **Increase in enzymatic hydrolysis**
    - **Fermentation rate increased due to chemical formation**

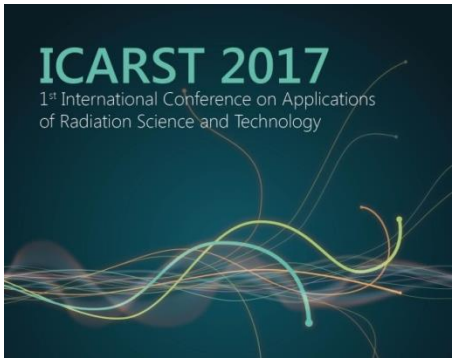


Conclusions

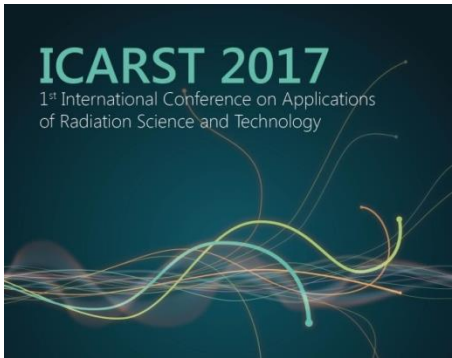
- **Electron beam irradiation is an excellent pretreatment method for lignocellulosic biomass used in a biorefinery.**

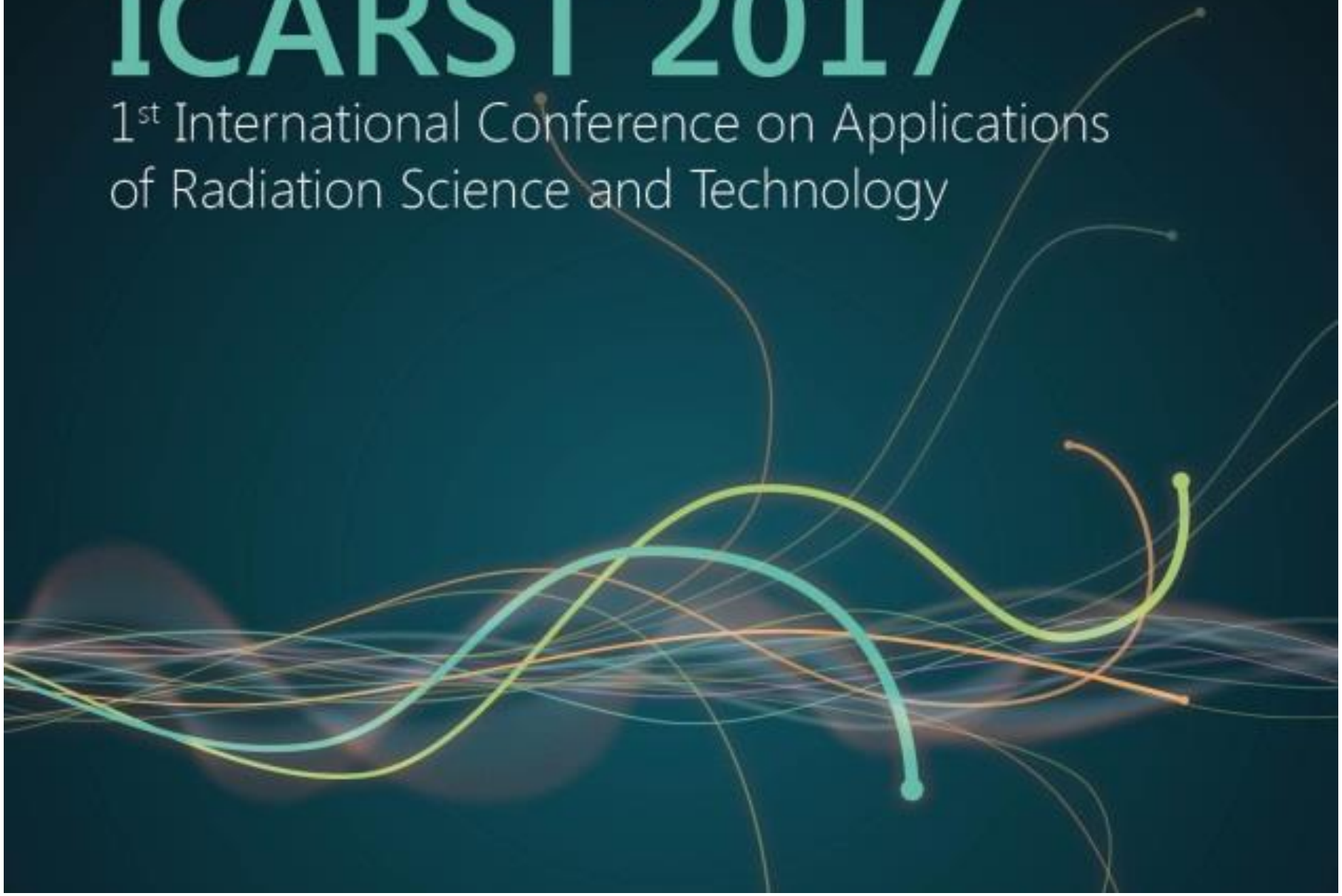


I would like to thank all the people at IBA Industrial especially Marsh Cleland and Rick Galloway.



Thank you for your attention



ICARST 2017

1st International Conference on Applications of Radiation Science and Technology