Soft Pellicle Project Update

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Agenda

- Transparency
- Degradation Mechanisms
- New Materials

Transparency

- Polymer systems need cross-linking, rings, heteroatoms, or branching to break up σ-conjugation (Source French et al. Dupont)
- Introducing hydrogen to improve transparency causes rapid degradation of all material in which it is used
- Systems can easily be designed and synthesized that meet the >70% initial transparency goal; however, all fail to survive or stabilize at useful transparencies
- The most transparent (and longest lived) species at 157nm are the perfluoropolyethers

Degradation Mechanisms

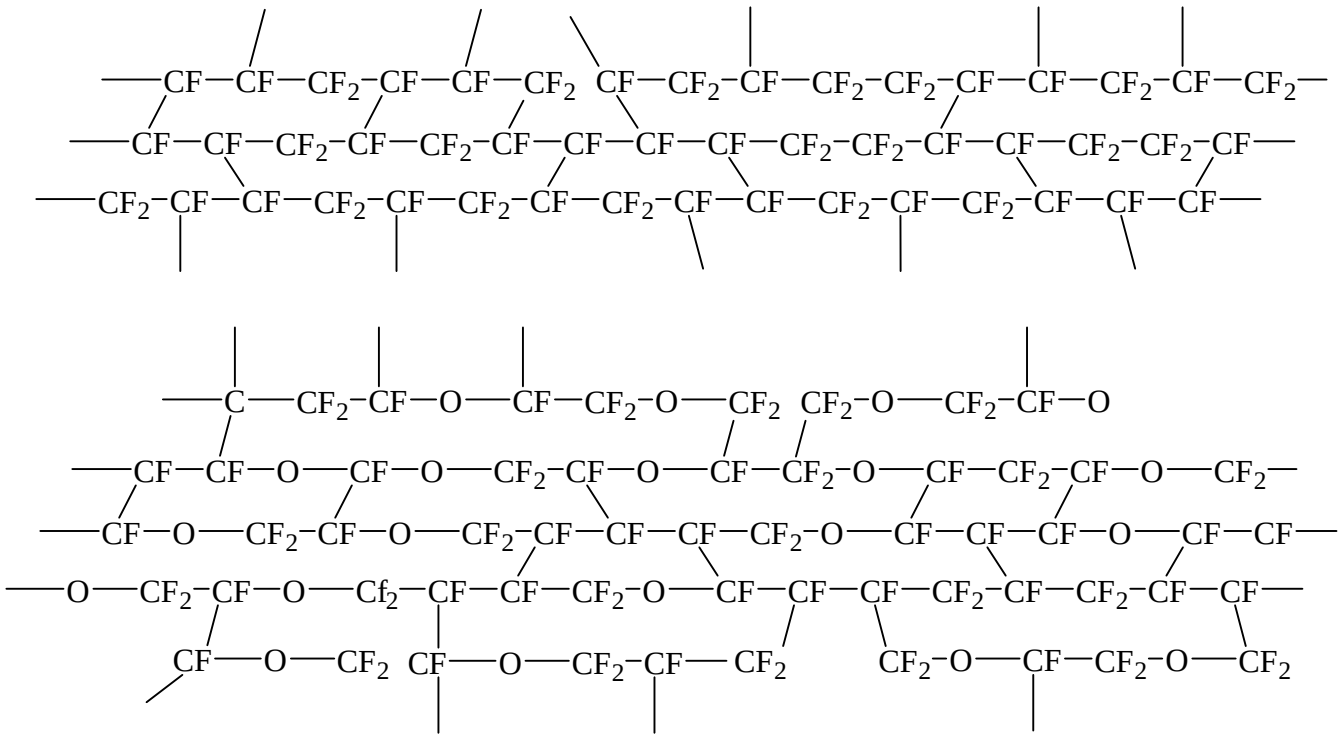
- **Presence of Hydrogen**
  - Determination was made by experimental and theoretical measurements that hydrogen causes rapid degradation of materials
  - Outgassing analysis indicates that HF is evolved during irradiation
  - Photochemical darkening
- **Presence of Rings in Polymer Backbones**
  - All five and six-member rings containing oxygen will decompose
    - Ring opening occurs in both systems
    - Cross linking/chain scission
  - Systems that posses polymer chains where there are adjacent rings are all doomed to rapid (<2J/cm^2) degradation
    - Chain scission is by far the dominant mechanism and cross linking is inhibited due to polymer structure

Degradation Mechanisms (Cont)

- **Free Radicals are formed during irradiation**
  - True for all systems analyzed to date (U of Queensland)
  - Free radicals are long-lived in tool environment but degrade rapidly upon exposure to open atmosphere
  - May need to quench the radicals to obtain sufficient lifetime-induced “self healing”
- **Indications are that polymer systems will survive longer if held at or near melt temperature**

Proposed New Materials

- **Work has lead to proposed ideal structures of two new family of polymers**



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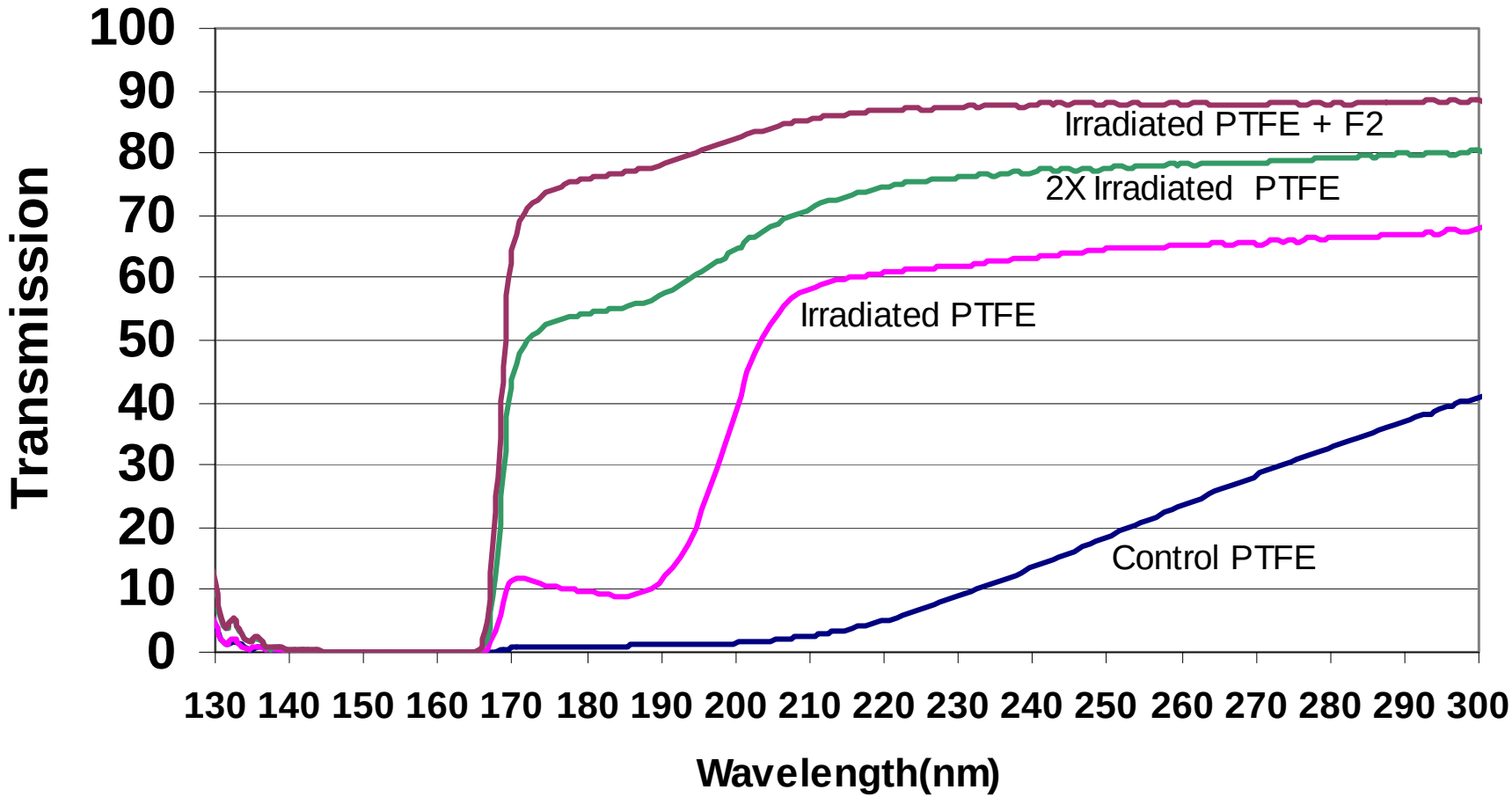
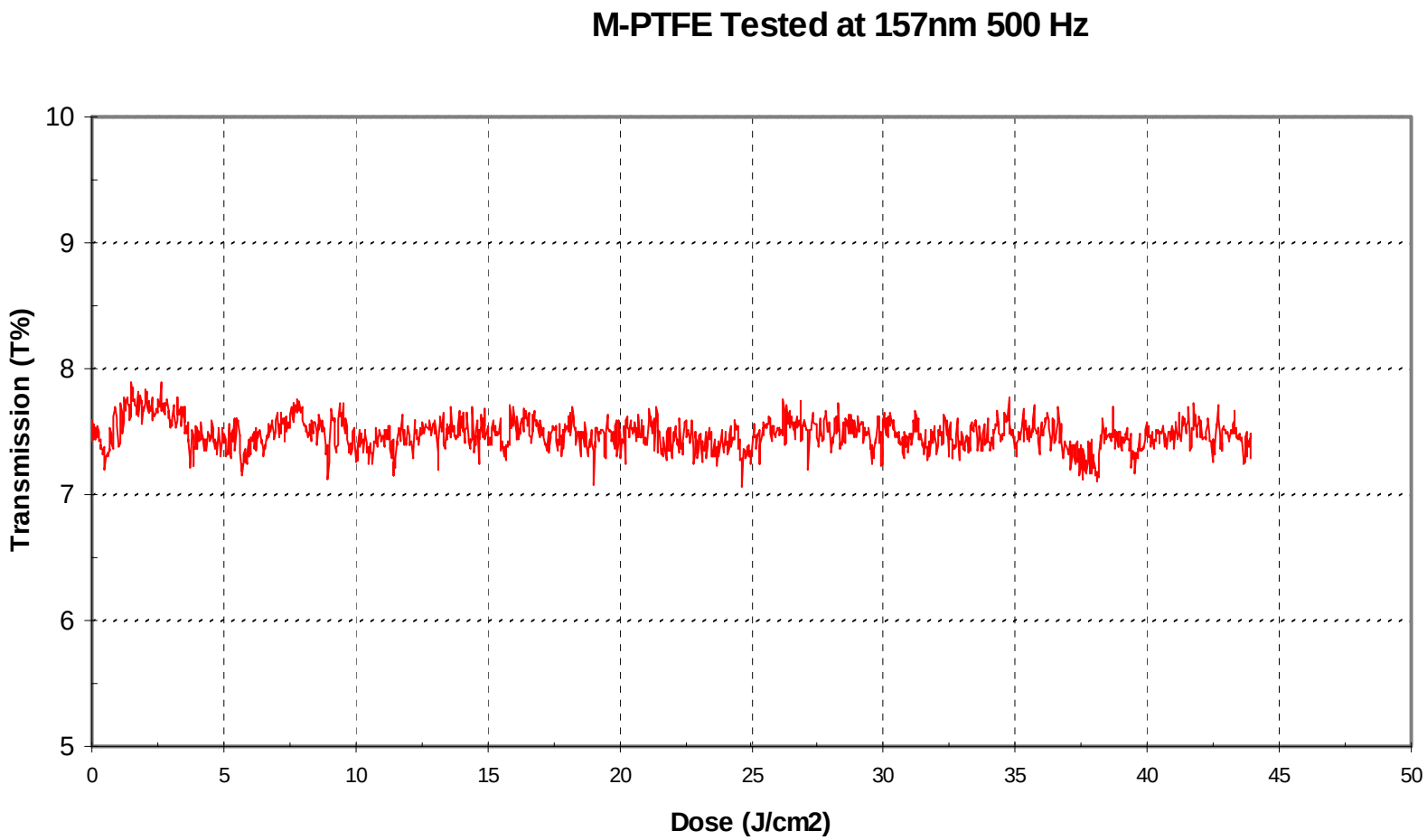
PTFE Transmission



Modified PTFE exposed at 157nm



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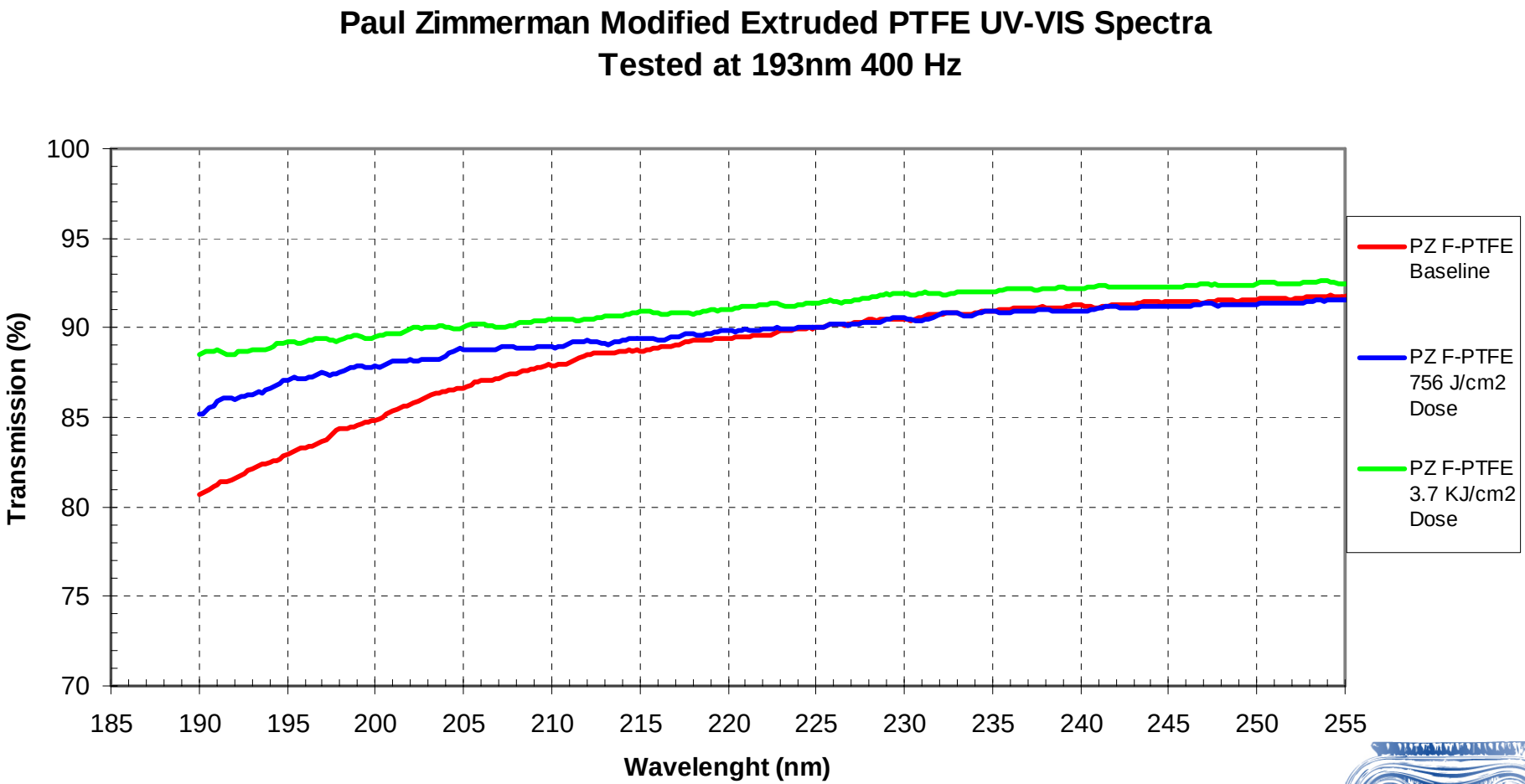
Modified PTFE at 193nm and 248nm



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New Steps

- **Continue chemical analysis of irradiated and exposed films**
- **Find someone to make “electronic grade” of polymer films**
- **Work with David Dixon (Univ. of Alabama) and Nick Turro’s group to understand sharp cutoff at 167nm for materials examined so far**
- **Find a PFA or some other material that incorporates substantially more oxygen into the the polymer framework**

Conclusions

- **Degradation Mechanisms of existing systems are well enough understood to create new materials**
  - New systems should be perfluorinated including end groups
  - New systems should not contain adjacent rings in the backbone
  - New systems should be highly cross linked to prevent sigma-conjugation and increased absorbance
  - New systems should contain oxygen in the main chain as a transparency enhancing atom
  - New systems should be designed so that “self-healing” does not materially change the polymer structure and absorbance
- **Elucidated mechanisms have lead to “desired structures” for new materials**
- **New materials have been made and are being evaluated**

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