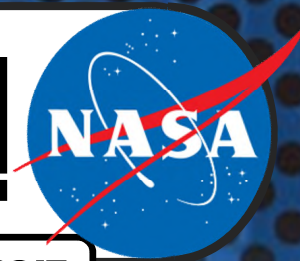




WE WANT A WINDOW !



COMICPALOOZA SCIENCE FICTION PANEL - MAY 23, 2015

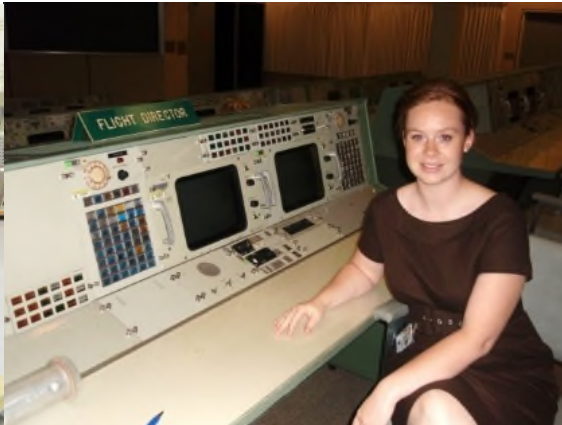


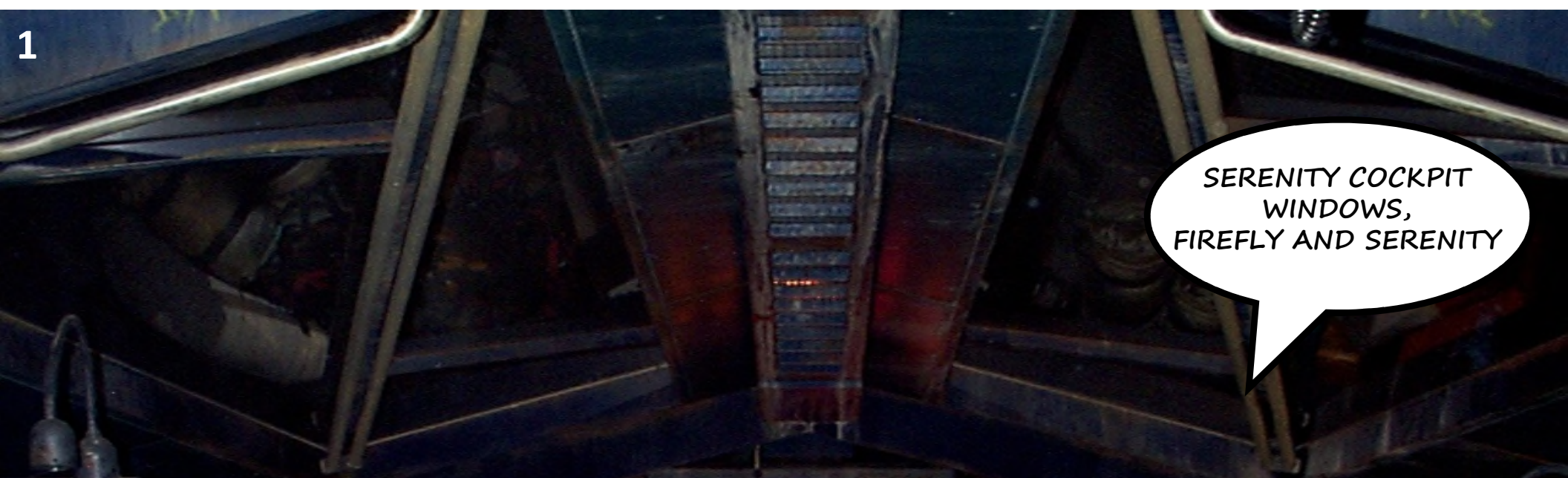
WHO AM I?



HANNAH BRADLEY

- STRUCTURAL WINDOW EXPERT, NASA JSC
 - ORION
 - COMMERCIAL CREW
 - ISS
- UNIVERSITY OF TEXAS LONGHORN
 - BS: MECHANICAL ENGINEERING
 - MINOR: PSYCHOLOGY
- 3RD GENERATION IN THE SPACE BUSINESS
- NERD





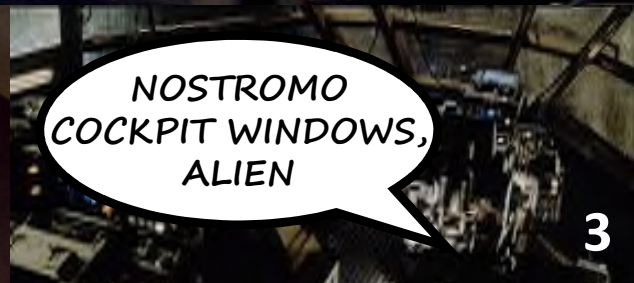
1

SERENITY COCKPIT
WINDOWS,
FIREFLY AND SERENITY



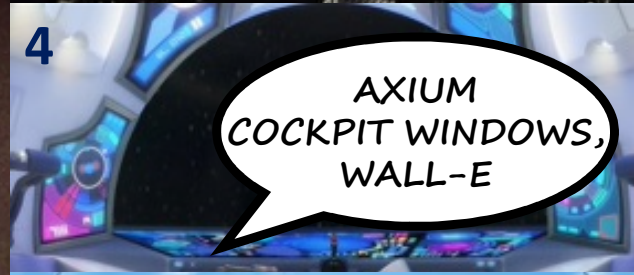
2

ENTERPRISE
VIEW SCREEN,
STAR TREK



NOSTROMO
COCKPIT WINDOWS,
ALIEN

3



4

AXIUM
COCKPIT WINDOWS,
WALL-E



5

AXIUM
SKY SCREEN DOME,
WALL-E



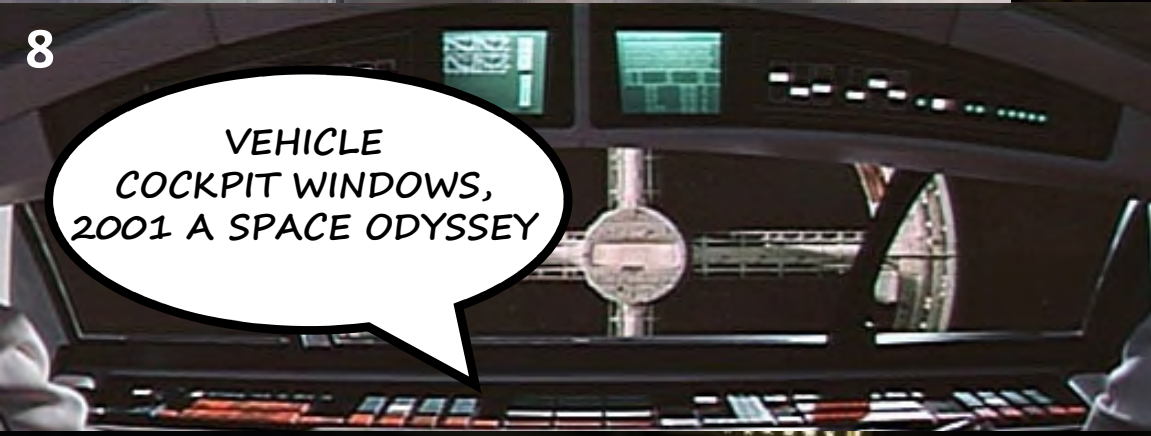
6

PUDDLE JUMPER
FORWARD WINDOW,
STARGATE ATLANTIS



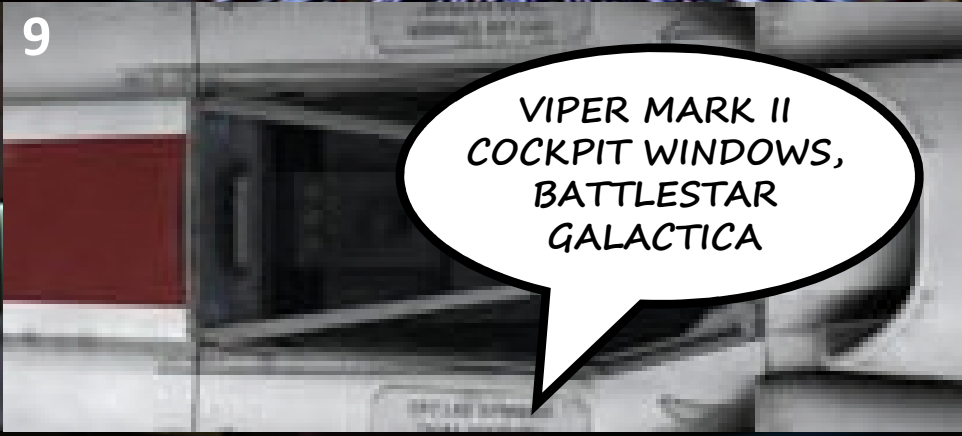
7

MILLENNIUM FALCON
COCKPIT WINDOWS,
STAR WARS



8

VEHICLE
COCKPIT WINDOWS,
2001 A SPACE ODYSSEY



9

VIPER MARK II
COCKPIT WINDOWS,
BATTLESTAR
GALACTICA



10

RANGER
COCKPIT WINDOWS,
INTERSTELLAR

11



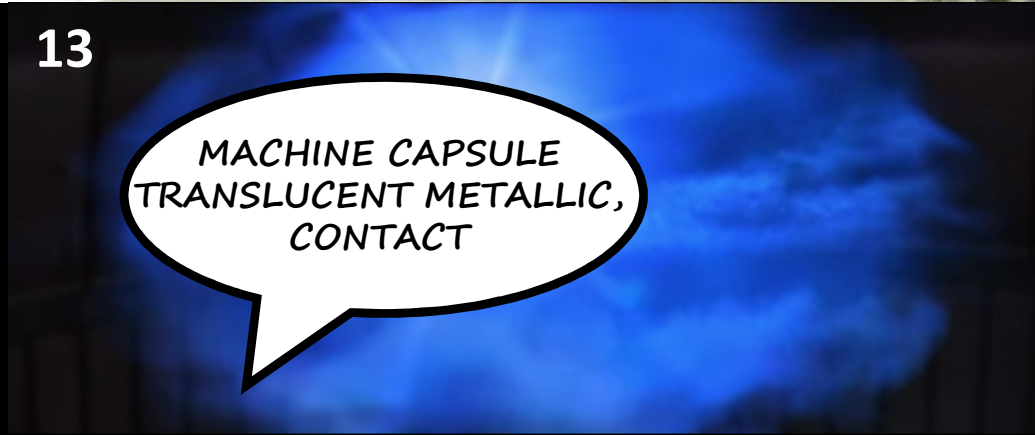
LUNARLAB
TRUCK WINDSHIELD,
MOON

12



MILANO
COCKPIT WINDOWS,
GUARDIANS OF THE
GALAXY

13



MACHINE CAPSULE
TRANSLUCENT METALLIC,
CONTACT

14



ALIEN ATTACKER
COCKPIT WINDOWS,
INDEPENDENCE DAY



INTERNATIONAL
SPACE STATION
CUPOLA WINDOWS

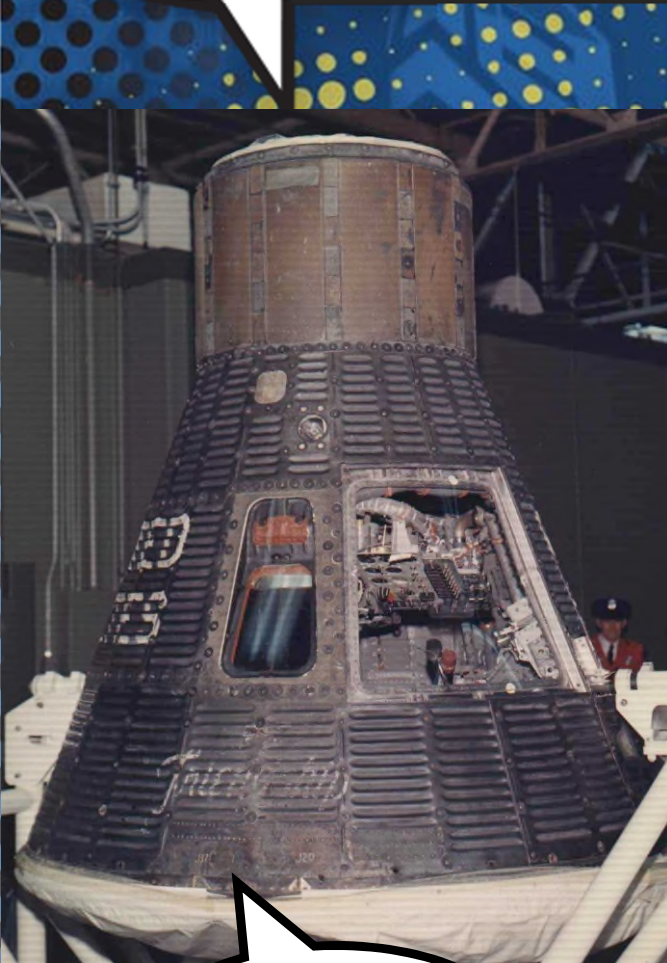
15



A BRIEF HISTORY...



- THE MERCURY 7 ASTRONAUTS DEMANDED A WINDOW ON THE CAPSULE
- SINCE THEN ALL AMERICAN SPACECRAFT HAVE HAD WINDOWS
 - MERCURY: 1 WINDOW, 1 PERISCOPE
 - GEMINI: 2 WINDOWS
 - APOLLO: CM - 5, LEM - 2
 - SKYLAB: 1 WINDOW
 - SHUTTLE: 13 WINDOWS
 - ISS: USA - 8, RUSSIA - 13, JAPAN - 2 (NOT INCLUDING HATCH WINDOWS)
 - ORION: 5 WINDOWS



MERCURY CAPSULE
WITH FINAL
WINDOW DESIGN



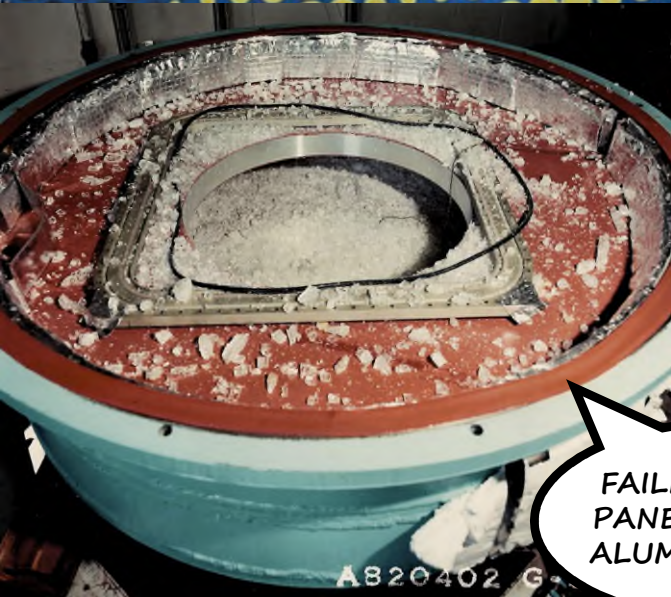
SPACE SHUTTLE
FORWARD WINDOWS



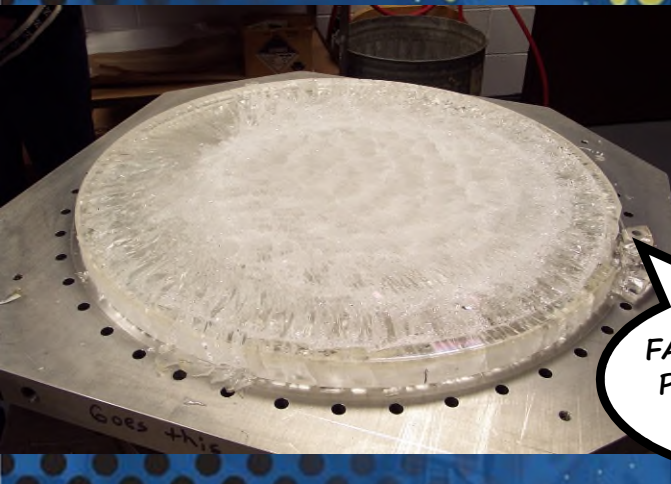
A BREIF HiSTORY...



- DOMINATE WINDOW MATERIAL HAS BEEN GLASS
 - THERMAL STABILITY
 - HIGH OPTICAL PERFORMANCE
- GLASS HAS ISSUES
 - BRITTLE!
 - IMPACT SENSITIVE
 - NO INHERANT SHTRENGTH
 - LOOSES STRENGTH OVER TIME
 - REQUIRES REDUNDANCY
 - HEAVY
 - EXPENSIVE

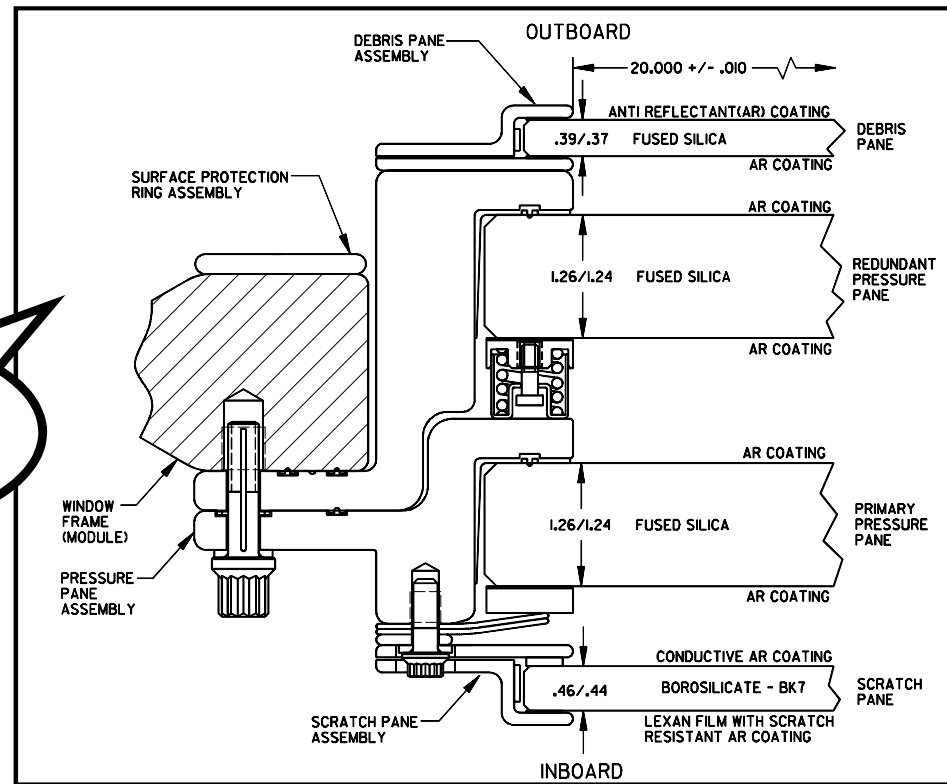


FAILED SHUTTLE PANE, TEMPERED ALUMINOSILICATE



FAILED ISS CUPOLA PANE, ANNEALED FUSED SILICA

ISS WINDOW CONFIGURATION, USA AND JAPAN





INNOVATIONS IN...



MATERIAL

- POLYMERS: ACRYLIC, POLYCARBONATE
 - PROS:
 - HUGELY INCREASED STRUCTURAL INTEGRITY
 - HALF THE WEIGHT OF GLASS
 - NO NEED FOR REDUNDANCY
 - LOW MAINTAINENCE
 - CHEAP
 - CONS:
 - ACRYLIC IS FLAMMIBLE
 - POLYCARBONATE HAS POOR OPITICS FOR LARGE APPERATURE PHOTOGRAPHY
- CLEAR CERAMICS: SAPPHIRE AND DERIVITAVES
 - PROS
 - HIGH FRACTURE TOUGHNESS
 - GLASS LIKE OPTICS
 - CONS
 - HEAVER THAN GLASS
 - STILL A BRITTLE MATERIAL

ACRYLIC (R) AND
POLYCARBONATE (L)
TENSILE TEST
SAMPLES

SAPPHIRE WINDOW
MATERIALS, EDMUND
OPTICS



AC-GKN350 PC-L9034



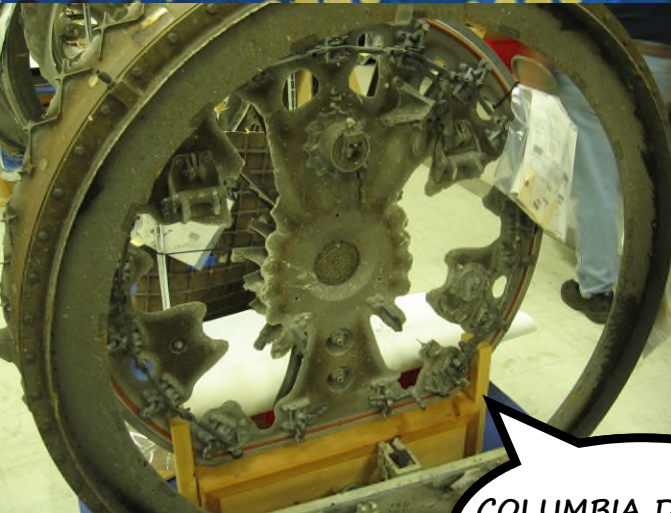


INNOVATIONS IN...

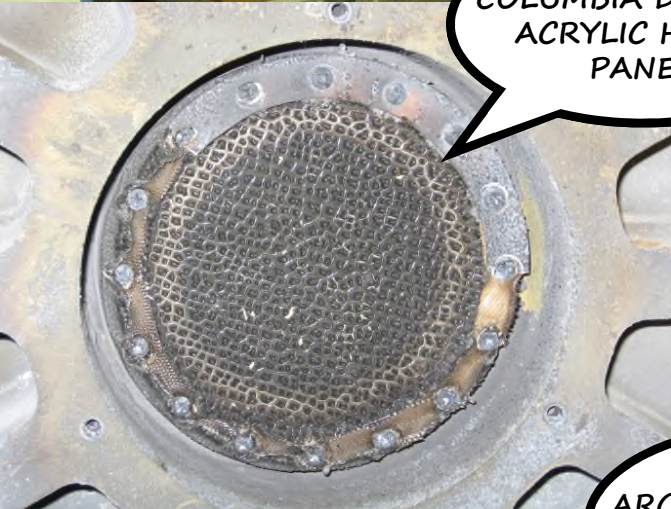


MATERIAL CAPABILITY

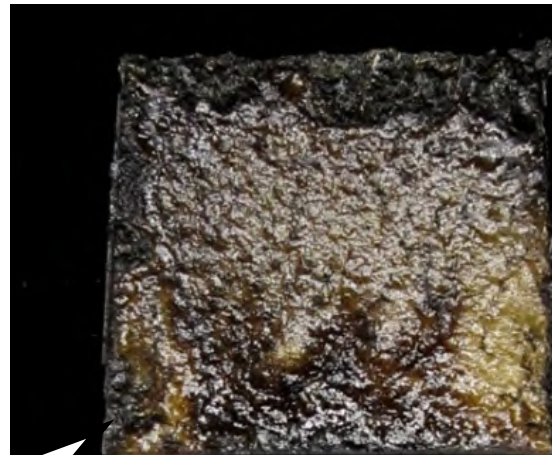
- COLUMBIA DEBRIS DISCOVERY...
 - MADE US QUESTION: IS IT POSSIBLE TO USE POLYMER MATERIALS AS THERMAL PROTECTION?
 - INSTINCT: NO
 - LOW MELTING POINT
 - TESTING: POSSIBLY!



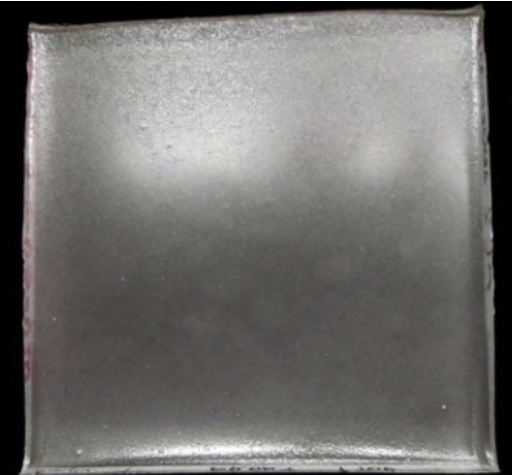
COLUMBIA DISASTER
ACRYLIC HATCH
PANES



RESULTS OF
ARCJET TESTING OF
POLYCARBONATE
AND ACRYLIC



8/3/12 #3383
Polycarbonate, PC1 115 sec



8/7/12 #3388
Acrylic, AC2 116 sec

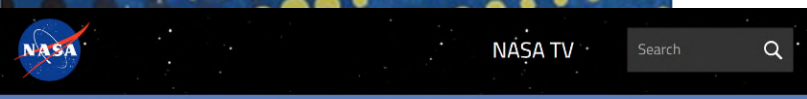


INNOVATIONS IN...



DESIGN SOLUTIONS

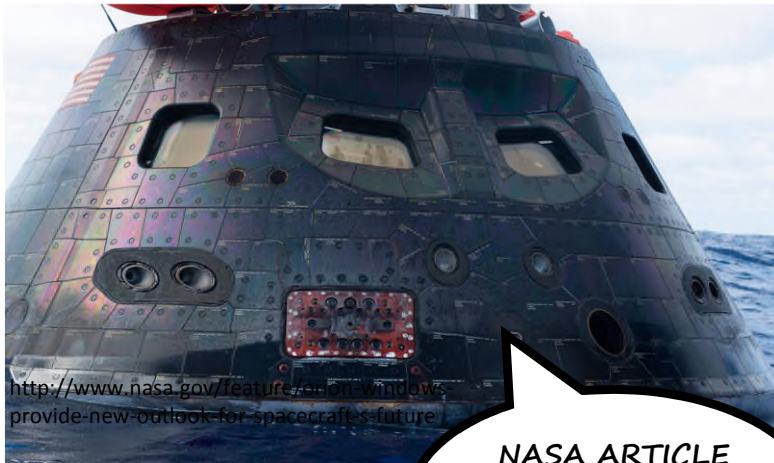
- LIGHT WEIGHT PRESSURE PANES
 - POLYMER PANES
- LIGHT WEIGHT THERMAL SYSTEM
 - POLYMERS AS REDUNDANT THERMAL PANES
 - SINGLE GLASS THERMAL PANES
- WINDOW MOUNTING
 - BONDED WINDOWS
- PANE PERFORMANCE
 - HIGH PERFORMANCE COATINGS
 - NEW POLISHING TECHNIQUES
- MAINTAINENCE
 - AUTOMATED INSPECTION DEVICES



Orion Spacecraft

April 30, 2015

Orion Windows Provide New Outlook for Spacecraft's Future



<http://www.nasa.gov/feature/orion-windows-provide-new-outlook-for-spacecraft-s-future>

NASA ARTICLE
HEADLINE FOR
WINDOW INNOVATION
ON ORION

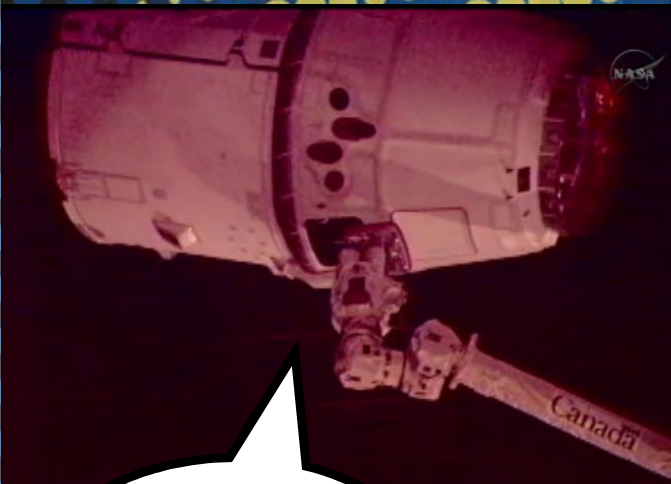


INNOVATIONS IN...



DIGITAL TECHNOLOGY

- VIRTUAL WINDOWS
 - PROS
 - MUCH HIGHER STRUCTURAL INTEGRITY OF PRESSURE VEHICLE OVERALL
 - FLEXIBILITY IN VIEWING AREA
 - ZOOM CAPABILITY
 - POTENTIAL WEIGHT SAVINGS
 - CONS
 - MALFUNCTIONS RESULT IN LOSS OF VISIBILITY
 - "WE WANT A WINDOW"



ISS EXTERNAL CAMERA WITH MALFUNCTION THAT CAUSES EVERYTHING TO LOOK PINK



IXION PRIVATE JET COMPANY'S CONCEPT OF VIRTUAL WINDOWS



QUESTIONS ?

