



1
00:00:07,307 --> 00:00:08,441
>> I'M BRITTANY BROWN,

2
00:00:08,441 --> 00:00:09,909
AND I WORK IN ES62.

3
00:00:09,909 --> 00:00:10,977
THE ENVIRONMENTAL CONTROL

4
00:00:10,977 --> 00:00:12,145
AND LIFE SUPPORT

5
00:00:12,145 --> 00:00:13,980
DESIGN AND DEVELOPMENT BRANCH.

6
00:00:13,980 --> 00:00:15,682
>> AND I AM ENRIQUE JACKSON.

7
00:00:15,682 --> 00:00:16,783
I WORK IN MATERIALS

8
00:00:16,783 --> 00:00:18,318
AND PROCESSING LABORATORY.

9
00:00:18,318 --> 00:00:20,220
EM22 AND THE CHEMISTRY TEAM.

10
00:00:20,220 --> 00:00:22,322
>> WE ARE PARTNERING TOGETHER

11
00:00:22,322 --> 00:00:24,491
ON A CAN AND SIFT PROJECT,

12
00:00:24,491 --> 00:00:25,959
WHICH UTILIZES BOSCH CARBON

13
00:00:25,959 --> 00:00:27,660

FOR ADVANCED MANUFACTURING.

14

00:00:27,660 --> 00:00:29,529

>> MY ROLE IN THE PROJECT IS

15

00:00:29,529 --> 00:00:31,131

TO DO ALL THE THERMAL ANALYSIS,

16

00:00:31,131 --> 00:00:32,699

USING DIFFERENTIAL

17

00:00:32,699 --> 00:00:34,134

SCANNING CALORIMETRY,

18

00:00:34,134 --> 00:00:37,036

WHICH IS DSC, AND TG/DTA,

19

00:00:37,036 --> 00:00:38,371

WHICH IS THERMOGRAVIMETRY

20

00:00:38,371 --> 00:00:40,039

DIFFERENTIAL THERMAL ANALYSIS,

21

00:00:40,039 --> 00:00:42,342

ON THESE MATERIALS.

22

00:00:42,342 --> 00:00:43,276

>> PAUL RUPAR,

23

00:00:43,276 --> 00:00:44,210

A CHEMISTRY PROFESSOR,

24

00:00:44,210 --> 00:00:45,145

AND MYSELF,

25

00:00:45,145 --> 00:00:46,146

HAD BEEN WORKING WITH

26
00:00:46,146 --> 00:00:47,280
POLYMER MATERIALS FOR A LOT--

27
00:00:47,280 --> 00:00:48,481
A BULK OF OUR CAREERS.

28
00:00:48,481 --> 00:00:50,483
AND WE MET SOME NASA PERSONNEL

29
00:00:50,483 --> 00:00:51,684
A FEW YEARS BACK,

30
00:00:51,684 --> 00:00:52,852
AND THEY LET US KNOW ABOUT SOME

31
00:00:52,852 --> 00:00:55,155
IMPORTANT RESEARCH QUESTIONS

32
00:00:55,155 --> 00:00:56,122
THAT THEY WERE TACKLING,

33
00:00:56,122 --> 00:00:57,323
AND HOW WE MIGHT BE ABLE

34
00:00:57,323 --> 00:00:58,825
TO HELP OUT WITH THAT.

35
00:00:58,825 --> 00:00:59,793
AND THE FIRST ASPECT

36
00:00:59,793 --> 00:01:00,860
OF WHAT WE'RE DOING

37
00:01:00,860 --> 00:01:02,295
IS TO DEVELOP POLYMERS

38
00:01:02,295 --> 00:01:04,264

THAT CAN SUPPORT IONIC LIQUIDS

39

00:01:04,264 --> 00:01:05,799

TO REMOVE CO2 FROM THE

40

00:01:05,799 --> 00:01:08,368

ATMOSPHERE OF SPACE CABINS

41

00:01:08,368 --> 00:01:09,569

FOR THE CREW.

42

00:01:09,569 --> 00:01:10,737

OBVIOUSLY, FOR HEALTH

43

00:01:10,737 --> 00:01:12,172

AND SAFETY CONCERNS,

44

00:01:12,172 --> 00:01:13,173

CO2 HAS TO BE REMOVED.

45

00:01:13,173 --> 00:01:14,374

WE DON'T WANNA BE

46

00:01:14,374 --> 00:01:15,642

BREATHING TOO MUCH CO2.

47

00:01:15,642 --> 00:01:16,876

IT CAUSES PROBLEMS.

48

00:01:16,876 --> 00:01:18,077

AND SO, THE FIRST THING

49

00:01:18,077 --> 00:01:19,279

WE'RE DOING IS DEVELOPING,

50

00:01:19,279 --> 00:01:20,814

LIKE I SAID, POLYMERS.

51
00:01:20,814 --> 00:01:22,782
UH, THINGS THAT LOOK LIKE THIS.

52
00:01:22,782 --> 00:01:24,350
WE'RE ABLE TO PROCESS AND,

53
00:01:24,350 --> 00:01:25,385
SPECIFICALLY, WE WANNA

54
00:01:25,385 --> 00:01:26,920
3D PRINT THESE MATERIALS.

55
00:01:26,920 --> 00:01:27,954
UH, WE'RE GONNA COMBINE

56
00:01:27,954 --> 00:01:29,022
WITH IONIC LIQUIDS,

57
00:01:29,022 --> 00:01:30,423
WHICH ARE SOLVENTS

58
00:01:30,423 --> 00:01:31,524
THAT HAVE NO VOLATILITY.

59
00:01:31,524 --> 00:01:33,092
SO THEY'RE VERY SAFE TO USE.

60
00:01:33,092 --> 00:01:34,527
UH, ESPECIALLY IN SPACE,

61
00:01:34,527 --> 00:01:36,062
WHERE THINGS MIGHT EVAPORATE.

62
00:01:36,062 --> 00:01:38,031
IT'S A VERY SAFE SOLVENT

63
00:01:38,031 --> 00:01:40,033

THAT CAN REACT WITH CO2.

64

00:01:40,033 --> 00:01:41,367
AND WHEN WE COMBINE THOSE,

65

00:01:41,367 --> 00:01:42,469
THEY'RE GONNA GRAB THE CO2

66

00:01:42,469 --> 00:01:44,037
FROM THE CABIN ATMOSPHERE

67

00:01:44,037 --> 00:01:45,939
AND MAKE THE CONDITIONS

68

00:01:45,939 --> 00:01:47,440
HOSPITABLE TOWARDS, UH,

69

00:01:47,440 --> 00:01:48,641
TOWARDS THE CREW

70

00:01:48,641 --> 00:01:51,010
IN-IN LONG-TERM, UH, MISSIONS.

71

00:01:51,010 --> 00:01:52,245
NASA IS CURRENTLY WORKING ON

72

00:01:52,245 --> 00:01:53,379
DIFFERENT OXYGEN RECOVERY

73

00:01:53,379 --> 00:01:54,414
TECHNOLOGIES FOR

74

00:01:54,414 --> 00:01:55,648
LONG DURATION MISSIONS.

75

00:01:55,648 --> 00:01:56,883
ONE TECHNOLOGY IS

76
00:01:56,883 --> 00:01:58,418
THE BOSCH PROCESS.

77
00:01:58,418 --> 00:01:59,853
THIS PROCESS TAKES METABOLIC

78
00:01:59,853 --> 00:02:01,454
CARBON DIOXIDE AND HYDROGEN

79
00:02:01,454 --> 00:02:02,555
TO PRODUCE WATER

80
00:02:02,555 --> 00:02:04,057
AND SOLID CARBON.

81
00:02:04,057 --> 00:02:06,893
AND IN THAT BOSCH REACTOR, UH,

82
00:02:06,893 --> 00:02:08,294
A REACTION-- A CHEMICAL REACTION

83
00:02:08,294 --> 00:02:09,963
HAPPENS WHERE CO₂ IS COMBINED

84
00:02:09,963 --> 00:02:11,998
WITH THE HYDROGEN TO MAKE WATER,

85
00:02:11,998 --> 00:02:13,199
WHICH IS OBVIOUSLY

86
00:02:13,199 --> 00:02:14,901
A NEED FOR THE SPACE CREW.

87
00:02:14,901 --> 00:02:15,902
WE NEED DRINKING WATER.

88
00:02:15,902 --> 00:02:16,836

WE NEED WATER FOR

89

00:02:16,836 --> 00:02:17,871

ALL SORTS OF THINGS,

90

00:02:17,871 --> 00:02:18,738

TO-TO LIVE.

91

00:02:18,738 --> 00:02:20,073

UH, AND IT MAKES THAT WATER

92

00:02:20,073 --> 00:02:21,307

THAT WE CAN RECOVER AND USE,

93

00:02:21,307 --> 00:02:22,675

AS WELL AS IT MAKES SOMETHING

94

00:02:22,675 --> 00:02:25,011

CALLED, UH, BOSCH CARBON.

95

00:02:25,011 --> 00:02:26,145

WHAT DO WE DO WITH

96

00:02:26,145 --> 00:02:27,080

THE EXCESS CARBON,

97

00:02:27,080 --> 00:02:28,414

OR DOES IT CREATE A PROBLEM?

98

00:02:28,414 --> 00:02:29,949

AND, IN SOME RESPECTS,

99

00:02:29,949 --> 00:02:31,017

ONE MIGHT VIEW IT

100

00:02:31,017 --> 00:02:32,452

AS A WASTE PRODUCT.

101
00:02:32,452 --> 00:02:33,620
BUT I THINK, IN A RESOURCE

102
00:02:33,620 --> 00:02:35,421
CONSTRAINED ENVIRONMENT,

103
00:02:35,421 --> 00:02:36,956
SUCH AS IN A CABIN

104
00:02:36,956 --> 00:02:38,925
FOR SPACE TRAVEL, THAT CARBON

105
00:02:38,925 --> 00:02:40,260
CAN ACTUALLY BECOME AN ASSET.

106
00:02:40,260 --> 00:02:41,261
AND ONE OF THE REALLY

107
00:02:41,261 --> 00:02:42,362
CLEVER THINGS THAT, UH,

108
00:02:42,362 --> 00:02:43,429
THE PEOPLE AT NASA

109
00:02:43,429 --> 00:02:44,964
HAD THOUGHT UP WAS TO USE

110
00:02:44,964 --> 00:02:47,367
THAT BOSCH CARBON TO INCLUDE IT

111
00:02:47,367 --> 00:02:49,802
IN POLYMERS FOR 3D PRINTING.

112
00:02:49,802 --> 00:02:50,837
ALL RIGHT, SO NOW I DON'T HAVE

113
00:02:50,837 --> 00:02:51,971

TO BRING UP AS MUCH MATERIAL

114

00:02:51,971 --> 00:02:54,340

WITH ME, UM, INTO SPACE.

115

00:02:54,340 --> 00:02:55,742

AND THEN IF I CAN USE

116

00:02:55,742 --> 00:02:57,143

THE BOSCH CARBON IN 3D PRINTING,

117

00:02:57,143 --> 00:02:58,945

I CAN MAKE WHAT I NEED,

118

00:02:58,945 --> 00:03:00,313

WHEN I NEED IT, AND I CAN

119

00:03:00,313 --> 00:03:01,548

USE THAT CARBON TO KIND OF

120

00:03:01,548 --> 00:03:03,683

EXTEND THE AMOUNT OF RESOURCES

121

00:03:03,683 --> 00:03:05,251

THAT I HAVE BY BLENDING IT

122

00:03:05,251 --> 00:03:06,886

WITH THE POLYMER.

123

00:03:06,886 --> 00:03:07,987

SO IN THIS CASE,

124

00:03:07,987 --> 00:03:09,489

WHAT WE'RE WORKING ON IS

125

00:03:09,489 --> 00:03:11,357

WE'RE TAKING SILICON RESINS.

126
00:03:11,357 --> 00:03:12,358
AND THIS IS SILICON

127
00:03:12,358 --> 00:03:13,293
WITHOUT THE CARBON.

128
00:03:13,293 --> 00:03:14,394
IT'S JUST A TRANSPARENT,

129
00:03:14,394 --> 00:03:16,029
RUBBERY MATERIAL.

130
00:03:16,029 --> 00:03:17,463
AND WE TAKE THAT BOSCH CARBON,

131
00:03:17,463 --> 00:03:18,831
HERE, AND WE BLEND IT

132
00:03:18,831 --> 00:03:19,933
WITH THE SILICON,

133
00:03:19,933 --> 00:03:22,001
AND THE SILICON IS THEN CURED.

134
00:03:22,001 --> 00:03:23,369
AND REALLY COOL,

135
00:03:23,369 --> 00:03:25,204
WHAT WE WIND UP WITH ARE PARTS

136
00:03:25,204 --> 00:03:26,539
THAT ARE COMPOSED OF SILICON

137
00:03:26,539 --> 00:03:27,774
AND BOSCH CARBON.

138
00:03:27,774 --> 00:03:28,942

SO THIS IS JUST AN EXAMPLE

139

00:03:28,942 --> 00:03:31,144
OF THE CARBON INFUSED

140

00:03:31,144 --> 00:03:32,812
IN THAT SILICON MATRIX.

141

00:03:32,812 --> 00:03:34,080
AND WE GET THESE BLACK,

142

00:03:34,080 --> 00:03:35,048
UH, MATERIALS.

143

00:03:35,048 --> 00:03:36,749
AND WE CAN USE 3D PRINTING

144

00:03:36,749 --> 00:03:38,518
TO CAST MOLDS, UH,

145

00:03:38,518 --> 00:03:39,619
OR TO CREATE MOLDS.

146

00:03:39,619 --> 00:03:40,653
AND WE CAN FILL THEM WITH THE

147

00:03:40,653 --> 00:03:41,821
BOSCH CARBON AND THE SILICON.

148

00:03:41,821 --> 00:03:42,755
AND WE CAN MAKE THINGS

149

00:03:42,755 --> 00:03:44,757
ANY SHAPE, SIZE THAT WE WANT.

150

00:03:44,757 --> 00:03:46,492
SO, AGAIN, NASA CREW WILL

151
00:03:46,492 --> 00:03:47,860
BE ABLE TO MAKE THINGS

152
00:03:47,860 --> 00:03:49,228
AS THEY NEED THEM, UH,

153
00:03:49,228 --> 00:03:50,296
FROM THINGS LIKE SILICON

154
00:03:50,296 --> 00:03:51,397
OR OTHER RESINS.

155
00:03:51,397 --> 00:03:52,966
AND USE THAT BOSCH CARBON,

156
00:03:52,966 --> 00:03:54,267
WHICH IS PRODUCED, ESSENTIALLY,

157
00:03:54,267 --> 00:03:55,301
FROM OUR BREATHING.

158
00:03:55,301 --> 00:03:56,269
BUT, OFTEN TIMES,

159
00:03:56,269 --> 00:03:57,370
THE BEST RESEARCH

160
00:03:57,370 --> 00:03:58,771
LEADS TO MORE QUESTIONS.

161
00:03:58,771 --> 00:04:00,406
SO ONE THING WE LIKE TO DO

162
00:04:00,406 --> 00:04:02,942
IS TO WORK ON REFINING

163
00:04:02,942 --> 00:04:03,910

THE BOSCH CARBON,

164

00:04:03,910 --> 00:04:05,378

IN TERMS OF ITS PARTICLE SIZE

165

00:04:05,378 --> 00:04:06,946

AND UNIFORMITY SO THAT WE GET

166

00:04:06,946 --> 00:04:08,114

EVEN BETTER PERFORMANCE

167

00:04:08,114 --> 00:04:09,582

OUT OF THE MATERIALS,