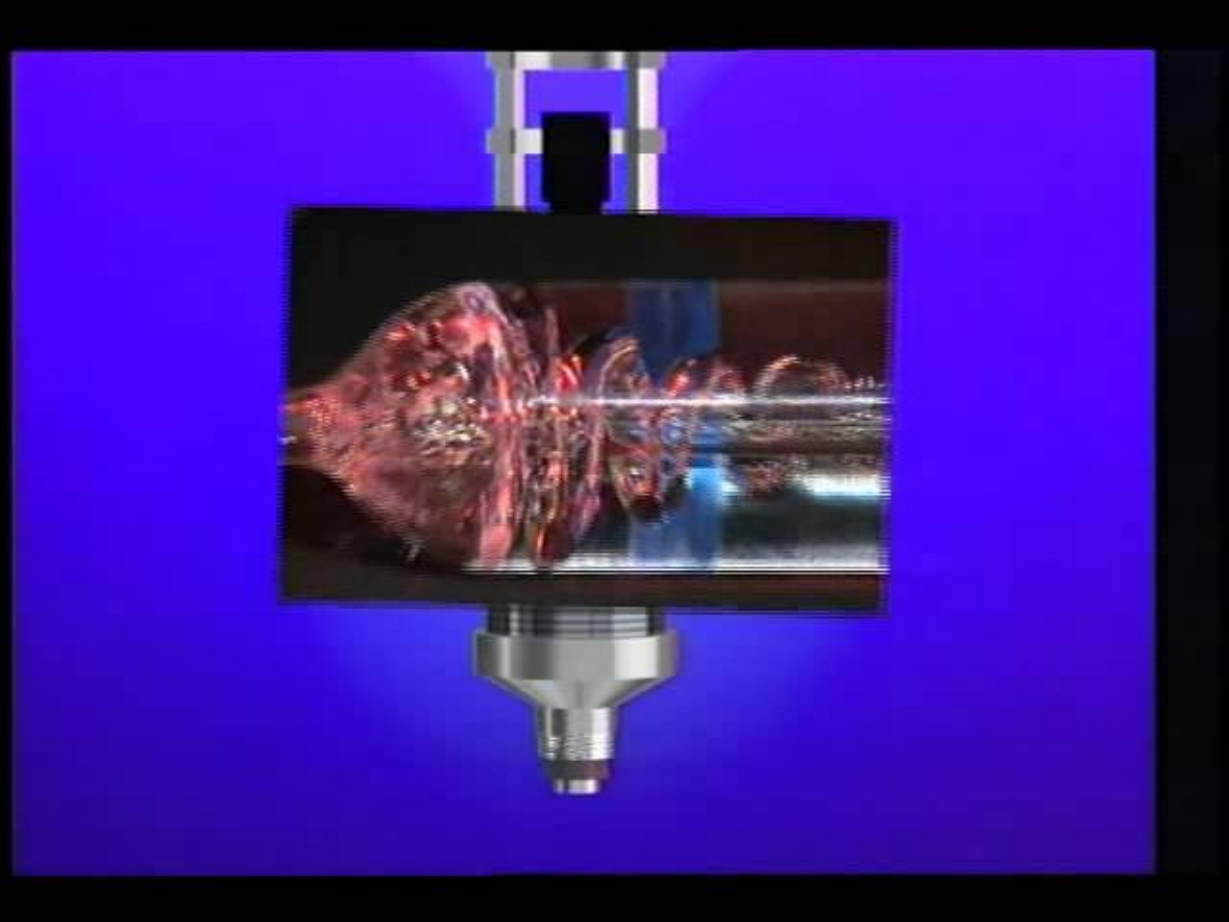

1
00:00:00,000 --> 00:00:53,310
I

2
00:01:05,520 --> 00:00:58,950
then k minus nine eight seven six five

3
00:01:08,340 --> 00:01:05,530
four three two one solid rocket ignition

4
00:01:40,209 --> 00:01:08,350
and liftoff liftoff of Columbia on a

5
00:01:46,190 --> 00:01:42,800
the isothermal dendritic growth

6
00:01:49,130 --> 00:01:46,200
experiment or idge is a microgravity

7
00:01:51,170 --> 00:01:49,140
material science experiment plan to fly

8
00:01:53,389 --> 00:01:51,180
on board the space shuttle Columbia as

9
00:01:56,539 --> 00:01:53,399
part of the United States microgravity

10
00:01:58,880 --> 00:01:56,549
payload mission it is a fundamental

11
00:02:01,100 --> 00:01:58,890
materials research experiment to help

12
00:02:03,919 --> 00:02:01,110
better understand and correlate what

13
00:02:05,899 --> 00:02:03,929

parameters affect the size and shape of

14
00:02:10,040 --> 00:02:05,909
crystals which determine the final

15
00:02:11,600 --> 00:02:10,050
properties of materials idge was

16
00:02:14,449 --> 00:02:11,610
conceived at the Rensselaer Polytechnic

17
00:02:16,430 --> 00:02:14,459
Institute in Troy New York which is

18
00:02:19,339 --> 00:02:16,440
responsible for the science and

19
00:02:22,880 --> 00:02:19,349
dendritic growth chamber development dr.

20
00:02:26,390 --> 00:02:22,890
Martin a gliksin of rpi is the idge

21
00:02:30,080 --> 00:02:26,400
principal investigator well what we hope

22
00:02:34,220 --> 00:02:30,090
to accomplish in the idg experiment is

23
00:02:35,380 --> 00:02:34,230
to be able to observe the growth rates

24
00:02:37,720 --> 00:02:35,390
and

25
00:02:42,160 --> 00:02:37,730
krystal morphologies of dendritic

26
00:02:43,870 --> 00:02:42,170
crystals as they form and develop in the

27
00:02:49,890 --> 00:02:43,880
microgravity environment of low-earth

28
00:02:53,140 --> 00:02:49,900
orbit this experiment will constitute a

29
00:02:56,490 --> 00:02:53,150
basic check of the physics theories of

30
00:03:01,150 --> 00:02:56,500
dendritic growth and provide some

31
00:03:04,479 --> 00:03:01,160
critical data for the assessment of the

32
00:03:06,760 --> 00:03:04,489
scientific concepts that form the

33
00:03:08,770 --> 00:03:06,770
framework of our understanding of this

34
00:03:12,850 --> 00:03:08,780
rather important metallurgical

35
00:03:15,310 --> 00:03:12,860
phenomenon the experiment will take

36
00:03:17,350 --> 00:03:15,320
place inside this experiment apparatus

37
00:03:19,930 --> 00:03:17,360
container which will be mounted on the

38
00:03:22,840 --> 00:03:19,940

support structure inside the cargo bay

39
00:03:25,330 --> 00:03:22,850
of the spacecraft the experiment

40
00:03:28,030 --> 00:03:25,340
apparatus is a miniaturized automated

41
00:03:30,610 --> 00:03:28,040
space laboratory that was designed and

42
00:03:33,540 --> 00:03:30,620
built by a team of engineers at the NASA

43
00:03:36,370 --> 00:03:33,550
Lewis Research Center in Cleveland Ohio

44
00:03:39,040 --> 00:03:36,380
the specific objective of this space

45
00:03:41,440 --> 00:03:39,050
experiment is to improve the quality of

46
00:03:44,620 --> 00:03:41,450
metals through the study of sixy known

47
00:03:47,140 --> 00:03:44,630
nitrile this material was chosen because

48
00:03:50,110 --> 00:03:47,150
it mimics the behavior of iron in its

49
00:03:52,900 --> 00:03:50,120
melting and solidifying process with one

50
00:03:56,860 --> 00:03:52,910
additional advantage it is clear and

51
00:03:59,590 --> 00:03:56,870
transparent metals are not transparent

52
00:04:02,650 --> 00:03:59,600
we cannot see what is happening to their

53
00:04:04,420 --> 00:04:02,660
structure when they solidify if we were

54
00:04:06,310 --> 00:04:04,430
able to better understand what is

55
00:04:08,289 --> 00:04:06,320
occurring to the crystalline structure

56
00:04:10,060 --> 00:04:08,299
of the metal we would stand a much

57
00:04:13,479 --> 00:04:10,070
greater chance of improving its

58
00:04:16,930 --> 00:04:13,489
qualities that then is the objective of

59
00:04:19,240 --> 00:04:16,940
this space experiment this containment

60
00:04:21,610 --> 00:04:19,250
vessel houses the device through which

61
00:04:24,340 --> 00:04:21,620
we will attempt to learn and understand

62
00:04:28,360 --> 00:04:24,350
the internal changes taking place inside

63
00:04:30,159 --> 00:04:28,370

these solidifying materials inside the

64
00:04:32,710 --> 00:04:30,169
containment vessel of the automated

65
00:04:35,950 --> 00:04:32,720
space laboratory there is an isothermal

66
00:04:38,020 --> 00:04:35,960
bath it is a two gallon tank filled with

67
00:04:39,850 --> 00:04:38,030
a mixture of ethylene glycol and water

68
00:04:42,670 --> 00:04:39,860
in which the temperature can be

69
00:04:46,570 --> 00:04:42,680
maintained to within two thousandth of a

70
00:04:48,150 --> 00:04:46,580
degree it has a heater coil in it and a

71
00:04:50,910 --> 00:04:48,160
small impeller down at the

72
00:04:53,310 --> 00:04:50,920
to assure good mixing of the ethylene

73
00:04:55,380 --> 00:04:53,320
glycol and water so that there is an

74
00:04:59,160 --> 00:04:55,390
even temperature distribution within the

75
00:05:01,080 --> 00:04:59,170
vessel the isothermal tank also has four

76
00:05:03,960 --> 00:05:01,090
windows on it to accommodate the

77
00:05:07,350 --> 00:05:03,970
necessary photography mounted to the

78
00:05:10,710 --> 00:05:07,360
tank are 2 35 millimeter cameras which

79
00:05:13,650 --> 00:05:10,720
record the dendritic growth and to slow

80
00:05:16,670 --> 00:05:13,660
scan television cameras the television

81
00:05:19,920 --> 00:05:16,680
cameras monitor the dendritic growth and

82
00:05:23,190 --> 00:05:19,930
activate the 35 millimeter cameras when

83
00:05:25,200 --> 00:05:23,200
growth and the experiment begins the

84
00:05:28,050 --> 00:05:25,210
rack around the tank provides a place to

85
00:05:30,240 --> 00:05:28,060
mount the circuit boards the experiments

86
00:05:32,010 --> 00:05:30,250
will take place inside this growth

87
00:05:33,450 --> 00:05:32,020
chamber which was conceived and

88
00:05:37,080 --> 00:05:33,460

developed at Rensselaer Polytechnic

89
00:05:40,080 --> 00:05:37,090
Institute the chamber is constructed out

90
00:05:42,570 --> 00:05:40,090
of stainless steel and glass their

91
00:05:45,450 --> 00:05:42,580
misters extend from the bottom of the

92
00:05:48,240 --> 00:05:45,460
growth chamber up into the volume of 16

93
00:05:50,340 --> 00:05:48,250
Oh nitrile they measure the temperature

94
00:05:53,630 --> 00:05:50,350
of the dendritic growth with an accuracy

95
00:05:57,600 --> 00:05:53,640
of two thousandth of a degree Celsius

96
00:06:00,690 --> 00:05:57,610
sixy no nitrile or SCM is encapsulated

97
00:06:05,220 --> 00:06:00,700
in the volume of the growth chamber the

98
00:06:07,860 --> 00:06:05,230
scn is 99.9 percent pure and was chosen

99
00:06:11,150 --> 00:06:07,870
because it mimics the behavior of iron

100
00:06:14,400 --> 00:06:11,160
in its melting and solidifying process

101
00:06:18,080 --> 00:06:14,410
Sen is a solid at room temperature and

102
00:06:21,090 --> 00:06:18,090
melts at 58 degrees centigrade that's

103
00:06:23,940 --> 00:06:21,100
136 degrees Fahrenheit

104
00:06:26,340 --> 00:06:23,950
now let's take a closer look at what we

105
00:06:29,610 --> 00:06:26,350
expect to achieve and learn through

106
00:06:32,010 --> 00:06:29,620
these experiments during the

107
00:06:35,430 --> 00:06:32,020
solidification process dendrites are

108
00:06:38,070 --> 00:06:35,440
formed dendrites are branching tree like

109
00:06:41,010 --> 00:06:38,080
crystals that form during industrial

110
00:06:43,170 --> 00:06:41,020
metal production understanding and

111
00:06:45,090 --> 00:06:43,180
correlating what parameters affect the

112
00:06:47,780 --> 00:06:45,100
size and shape of this crystallization

113
00:06:50,010 --> 00:06:47,790

will help us to understand and

114
00:06:52,740 --> 00:06:50,020
subsequently be able to predict the

115
00:06:55,980 --> 00:06:52,750
final properties of many metals alloys

116
00:06:58,380 --> 00:06:55,990
and super alloys and how we propose

117
00:07:00,330 --> 00:06:58,390
gathering that information is through

118
00:07:04,260 --> 00:07:00,340
this isothermal dendritic growth

119
00:07:07,590 --> 00:07:04,270
experiment the growth chamber is filled

120
00:07:10,830 --> 00:07:07,600
with scn material and contains a stinger

121
00:07:14,160 --> 00:07:10,840
that is used to form the dendrites first

122
00:07:16,550 --> 00:07:14,170
the scn material is melted by raising

123
00:07:20,700 --> 00:07:16,560
the temperature of the isothermal bath

124
00:07:23,430 --> 00:07:20,710
the molten scn is then cooled to just

125
00:07:26,430 --> 00:07:23,440
below its freezing point by reducing the

126
00:07:28,950 --> 00:07:26,440
temperature of the isothermal bath the

127
00:07:31,200 --> 00:07:28,960
scn will not solidify at this

128
00:07:34,260 --> 00:07:31,210
temperature because it is such a pure

129
00:07:36,300 --> 00:07:34,270
material the stinger is a hollow shaft

130
00:07:39,180 --> 00:07:36,310
which is also filled with the polymer

131
00:07:41,660 --> 00:07:39,190
scn and extends right into the volume of

132
00:07:43,950 --> 00:07:41,670
this scn material in the growth chamber

133
00:07:46,200 --> 00:07:43,960
using thermal electric coolers

134
00:07:48,120 --> 00:07:46,210
additional chilling is started at the

135
00:07:50,870 --> 00:07:48,130
top of the stinger shaft which is

136
00:07:53,630 --> 00:07:50,880
located outside of the growth chamber

137
00:07:56,570 --> 00:07:53,640
as the Stinger cools too far below the

138
00:07:59,500 --> 00:07:56,580

freezing point the scn inside the shaft

139
00:08:02,870 --> 00:07:59,510
solidifies the solidification process

140
00:08:05,180 --> 00:08:02,880
moves down the shaft and pops out at the

141
00:08:08,780 --> 00:08:05,190
stinger tip which is being monitored by

142
00:08:12,140 --> 00:08:08,790
the slow scan television cameras when

143
00:08:14,810 --> 00:08:12,150
the SS TV and associated software spot a

144
00:08:17,480 --> 00:08:14,820
dendrite forming the 35 millimeter

145
00:08:20,000 --> 00:08:17,490
cameras are triggered the cameras are

146
00:08:22,550 --> 00:08:20,010
set to expose six pictures at regular

147
00:08:25,700 --> 00:08:22,560
intervals as the dendrite grows to fill

148
00:08:27,860 --> 00:08:25,710
the field of view this entire process is

149
00:08:30,590 --> 00:08:27,870
monitored in Huntsville Alabama at

150
00:08:32,060 --> 00:08:30,600
NASA's Marshall Space Flight Center to

151
00:08:35,150 --> 00:08:32,070
assure that the experiment is

152
00:08:38,510 --> 00:08:35,160
progressing as expected in the payload

153
00:08:40,250 --> 00:08:38,520
operations control center or POC the

154
00:08:43,400 --> 00:08:40,260
growth velocity of the dendrite is

155
00:08:45,920 --> 00:08:43,410
measured if necessary timing of the

156
00:08:48,410 --> 00:08:45,930
experiment can be adjusted and remelted

157
00:08:51,620 --> 00:08:48,420
to repeat the experiment as often as

158
00:08:53,960 --> 00:08:51,630
might be required after the flight the

159
00:08:58,400 --> 00:08:53,970
35 millimeter photos will be analyzed

160
00:09:01,100 --> 00:08:58,410
for size and shape information these are

161
00:09:02,990 --> 00:09:01,110
dendrites which were grown on earth you

162
00:09:06,560 --> 00:09:03,000
can see the effects of gravity in their

163
00:09:09,320 --> 00:09:06,570

formation there are no arms or branches

164
00:09:11,750 --> 00:09:09,330
on top of the stand right as this

165
00:09:15,080 --> 00:09:11,760
material solidifies it gives off the

166
00:09:17,300 --> 00:09:15,090
heat of fusion the heat works upward

167
00:09:20,690 --> 00:09:17,310
causing the top of the sample to stay a

168
00:09:23,300 --> 00:09:20,700
little bit hotter as a result the bottom

169
00:09:27,680 --> 00:09:23,310
solidifies a little sooner than the top

170
00:09:30,320 --> 00:09:27,690
as the bottom cools gravity is creating

171
00:09:33,320 --> 00:09:30,330
a force which speeds up the downward

172
00:09:36,320 --> 00:09:33,330
growth of the arms of the dendrite these

173
00:09:38,480 --> 00:09:36,330
convective forces confound the effect of

174
00:09:40,460 --> 00:09:38,490
dendritic growth and make it difficult

175
00:09:43,760 --> 00:09:40,470
to understand the formation of these

176
00:09:46,220 --> 00:09:43,770
dendrites the space environment will

177
00:09:48,110 --> 00:09:46,230
simplify this process and enable us to

178
00:09:49,740 --> 00:09:48,120
better understand the process of

179
00:09:52,440 --> 00:09:49,750
crystallization

180
00:09:54,810 --> 00:09:52,450
the dendrites will be more symmetrical

181
00:09:57,270 --> 00:09:54,820
because gravity will not be distorting

182
00:09:59,850 --> 00:09:57,280
the solidification process these

183
00:10:03,240 --> 00:09:59,860
experiments will be most beneficial to

184
00:10:05,250 --> 00:10:03,250
metal manufacturers they will provide a

185
00:10:07,710 --> 00:10:05,260
fundamental understanding of how

186
00:10:10,080 --> 00:10:07,720
dendrites grow so that we can better

187
00:10:12,990 --> 00:10:10,090
understand how to make predictions of

188
00:10:15,690 --> 00:10:13,000

the quality of an end product if we

189
00:10:19,080 --> 00:10:15,700
understand the process we can improve it

190
00:10:22,260 --> 00:10:19,090
if we can improve it we will be able to

191
00:10:24,990 --> 00:10:22,270
reduce scrap and produce stronger and

192
00:10:27,090 --> 00:10:25,000
more ductile materials it will be

193
00:10:29,460 --> 00:10:27,100
possible to achieve whatever kind of

194
00:10:32,640 --> 00:10:29,470
property may be needed to satisfy the

195
00:10:34,770 --> 00:10:32,650
consumer everyone making products out of

196
00:10:36,770 --> 00:10:34,780
any metal will benefit from what has

197
00:10:41,190 --> 00:10:36,780
learned from these experiments in the

198
00:10:43,620 --> 00:10:41,200
future automobiles airplanes ships and

199
00:10:45,630 --> 00:10:43,630
many other metal products will be a

200
00:10:48,210 --> 00:10:45,640
little better and somewhat less