NRL Differential Calorimeter
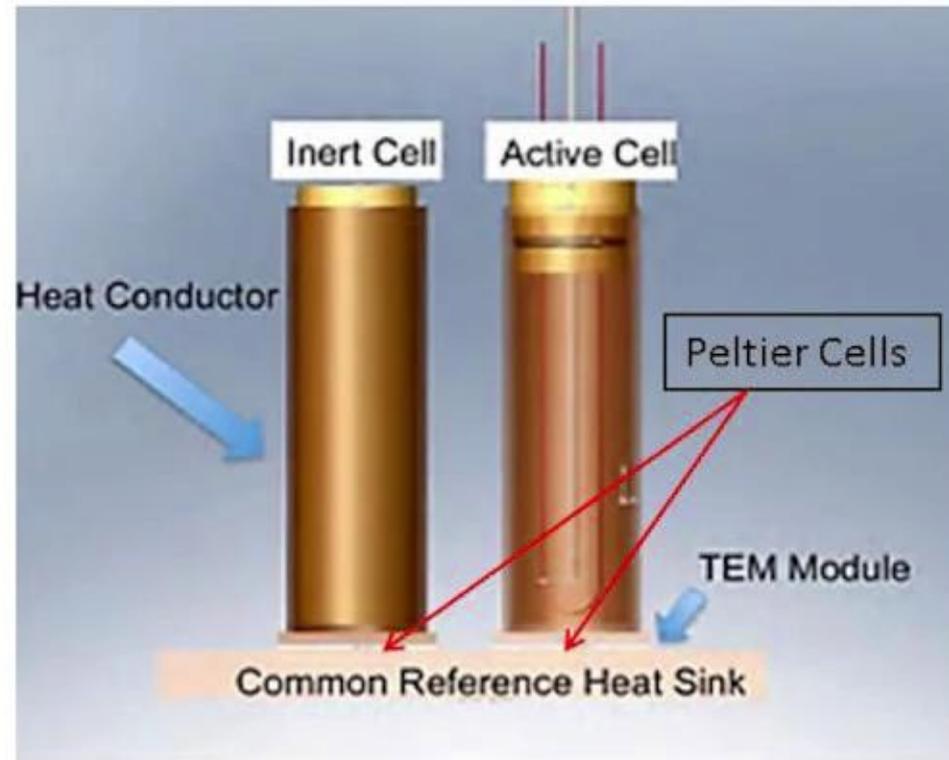

$$Pout = a + b*\Delta V$$

a = offset
b = gain
ΔV = ddp peltier

1
00:00:25,420 --> 00:00:16,080
[Music]

2
00:00:28,990 --> 00:00:25,430
ladies and gentlemen good morning it's

3
00:00:32,889 --> 00:00:29,000
my pleasure to say this conference I

4
00:00:36,280 --> 00:00:32,899
thank professor garret model for

5
00:00:41,220 --> 00:00:36,290
inviting me to stay at this event so we

6
00:00:44,470 --> 00:00:41,230
will approach the matter studying the

7
00:00:48,100 --> 00:00:44,480
research strategy we apply it with

8
00:00:50,770 --> 00:00:48,110
metallurgy calorimetry material science

9
00:00:55,090 --> 00:00:50,780
and reproducibility and study of the

10
00:00:57,729 --> 00:00:55,100
interface and then conclusions so for

11
00:01:00,010 --> 00:00:57,739
people that are not confident with the

12
00:01:02,080 --> 00:01:00,020
matter let me say that the Fleischmann

13
00:01:04,780 --> 00:01:02,090

and pons effect is the appearance of

14
00:01:07,929 --> 00:01:04,790
excess of energy when a Palladium

15
00:01:11,770 --> 00:01:07,939
cathode is electrolyzed at the in a

16
00:01:15,309 --> 00:01:11,780
water we have done a long work on that

17
00:01:19,289 --> 00:01:15,319
along 25 years including a revision of

18
00:01:22,749 --> 00:01:19,299
the effect and during this revision we

19
00:01:25,389 --> 00:01:22,759
obtained the signals very well above the

20
00:01:27,879 --> 00:01:25,399
measurement uncertainties and these

21
00:01:30,870 --> 00:01:27,889
measurements are confirming that the

22
00:01:33,730 --> 00:01:30,880
anomalous production of the excess of it

23
00:01:38,559 --> 00:01:33,740
during loading or palladium with the

24
00:01:41,109 --> 00:01:38,569
deuterium is real so such an effect as

25
00:01:46,059 --> 00:01:41,119
the following features is a threshold

26
00:01:48,669 --> 00:01:46,069
effect so there is no way to observe the

27
00:01:51,269 --> 00:01:48,679
onset of the effect if the atomic

28
00:01:55,449 --> 00:01:51,279
fraction of deuterium in palladium is

29
00:01:58,899 --> 00:01:55,459
below point nine is unobserved with

30
00:02:02,199 --> 00:01:58,909
hydrogen is not explainable as a

31
00:02:05,849 --> 00:02:02,209
chemical effect and it takes place only

32
00:02:08,650 --> 00:02:05,859
if materials are showing specific

33
00:02:13,000 --> 00:02:08,660
characteristics it seems to be a

34
00:02:17,210 --> 00:02:13,010
resonant effect and it seems that radio

35
00:02:20,210 --> 00:02:17,220
frequency emission is related to the

36
00:02:23,780 --> 00:02:20,220
effect so nevertheless

37
00:02:26,450 --> 00:02:23,790
in general this effect is considered to

38
00:02:31,940 --> 00:02:26,460

be a dangerous mistake by most of the

39
00:02:36,530 --> 00:02:31,950
scientific community so which one is the

40
00:02:40,910 --> 00:02:36,540
research approach we adopted so first of

41
00:02:43,880 --> 00:02:40,920
all we have done Ana 14 material science

42
00:02:50,270 --> 00:02:43,890
to increase both the reproducibility and

43
00:02:52,610 --> 00:02:50,280
the signals by enhancing the loading the

44
00:02:54,730 --> 00:02:52,620
calorimetric experiment have been

45
00:02:59,360 --> 00:02:54,740
considered that to have an appropriate

46
00:03:04,160 --> 00:02:59,370
signal noise ratio materials have been

47
00:03:06,770 --> 00:03:04,170
designed to control the effect and we

48
00:03:08,320 --> 00:03:06,780
like to obtain the definition of the

49
00:03:11,090 --> 00:03:08,330
effect through the materials

50
00:03:14,870 --> 00:03:11,100
characteristics and we want to use a

51
00:03:19,510 --> 00:03:14,880
statistic relevant data to develop a

52
00:03:26,270 --> 00:03:19,520
theoretical work concurrently with the

53
00:03:29,449 --> 00:03:26,280
experimental evidence so let's start

54
00:03:34,520 --> 00:03:29,459
with the reproducibility of loading mic

55
00:03:37,220 --> 00:03:34,530
Macabre several years ago demonstrated

56
00:03:41,800 --> 00:03:37,230
as you can see in in the first picture

57
00:03:45,920 --> 00:03:41,810
on the left side that the access is a

58
00:03:50,270 --> 00:03:45,930
parasol defect so in the abscissa you

59
00:03:55,009 --> 00:03:50,280
have the the the loading ratio of

60
00:03:58,070 --> 00:03:55,019
deuterium in Palio and the excess of

61
00:04:01,160 --> 00:03:58,080
power is plotted versus the loading

62
00:04:04,460 --> 00:04:01,170
ratio you can see that up to 0.9 about

63
00:04:07,699 --> 00:04:04,470

we don't have any access and then the

64
00:04:10,550 --> 00:04:07,709
excess increases and the larger the

65
00:04:14,449 --> 00:04:10,560
loading the largest v8 we access the

66
00:04:18,560 --> 00:04:14,459
loading is typically measured on the

67
00:04:21,560 --> 00:04:18,570
basis of the measurement of the electric

68
00:04:24,980 --> 00:04:21,570
electric resistivity of the Palladium

69
00:04:29,920 --> 00:04:24,990
Delta ride or I Drive in the plot on the

70
00:04:33,310 --> 00:04:29,930
right side you can see the evolution

71
00:04:37,930 --> 00:04:33,320
the resistance normalizes the resistance

72
00:04:40,600 --> 00:04:37,940
as function of the loading so it's very

73
00:04:42,999 --> 00:04:40,610
easy to realize on the basis of the

74
00:04:48,900 --> 00:04:43,009
measurement where we are this is our

75
00:04:51,670 --> 00:04:48,910
compass the loading of palladium is

76
00:04:56,110 --> 00:04:51,680
going until we achieve the equilibrium

77
00:04:58,420 --> 00:04:56,120
and equilibrium is achieved when the two

78
00:05:01,029 --> 00:04:58,430
interacting phases of the same chemical

79
00:05:03,189 --> 00:05:01,039
potential chemical potential is as most

80
00:05:05,409 --> 00:05:03,199
of you know much better than me that I'm

81
00:05:09,029 --> 00:05:05,419
a dynamic function telling us how the

82
00:05:11,920 --> 00:05:09,039
energy of system increases or decreasing

83
00:05:16,570 --> 00:05:11,930
decreases by adding or removing a

84
00:05:18,610 --> 00:05:16,580
particle so for a metal this for I'd

85
00:05:20,650 --> 00:05:18,620
urgent is solving in a metal the

86
00:05:23,140 --> 00:05:20,660
chemical potential as several

87
00:05:26,100 --> 00:05:23,150
contribution the first one is the

88
00:05:29,350 --> 00:05:26,110

standard then we have the configure

89
00:05:31,330 --> 00:05:29,360
configurational contribution the than

90
00:05:34,510 --> 00:05:31,340
the electronic contribution then the

91
00:05:37,719 --> 00:05:34,520
interaction of the protons with with

92
00:05:41,050 --> 00:05:37,729
lattice X is the atomic fraction of the

93
00:05:44,560 --> 00:05:41,060
hydrogen in the metal for gas loading

94
00:05:46,629 --> 00:05:44,570
the chemical potential is is a function

95
00:05:48,960 --> 00:05:46,639
of the fugacities all let me say the

96
00:05:52,210 --> 00:05:48,970
pressure that we apply to the system

97
00:05:54,430 --> 00:05:52,220
into an electrochemical loading the

98
00:05:57,730 --> 00:05:54,440
electrochemical overpotential

99
00:06:00,580 --> 00:05:57,740
replaces the pressure of hydrogen and

100
00:06:05,290 --> 00:06:00,590
the effective pressure given by the

101
00:06:09,279 --> 00:06:05,300
electrochemical approach is described by

102
00:06:12,129 --> 00:06:09,289
the annual a question this is some

103
00:06:14,589 --> 00:06:12,139
somehow an extended version of the

104
00:06:18,040 --> 00:06:14,599
Nernst equation if we try to apply the

105
00:06:21,339 --> 00:06:18,050
Nernst equation to this system we arrive

106
00:06:25,540 --> 00:06:21,349
at the paradox so the using the over

107
00:06:30,129 --> 00:06:25,550
voltage we have the the effective

108
00:06:32,800 --> 00:06:30,139
pressure will be 10 to the 20 atmosphere

109
00:06:37,029 --> 00:06:32,810
this is not true with the one volt of

110
00:06:39,969 --> 00:06:37,039
our voltage the effective pressure is 10

111
00:06:42,399 --> 00:06:39,979
to the 6 atmosphere is quite high so

112
00:06:43,200 --> 00:06:42,409
that's why it's much better to work with

113
00:06:46,260 --> 00:06:43,210

an electron

114
00:06:49,230 --> 00:06:46,270
system to put hydrogen into palladium

115
00:06:52,950 --> 00:06:49,240
instead of working with I Regina ten to

116
00:06:58,740 --> 00:06:52,960
the six atmospheres it's possible that

117
00:07:01,950 --> 00:06:58,750
is not simple so when we are working

118
00:07:05,490 --> 00:07:01,960
with the hydrogen dissolving into a

119
00:07:09,900 --> 00:07:05,500
metal lattice we are not leading with

120
00:07:14,370 --> 00:07:09,910
only with an equilibrium problem but we

121
00:07:18,719 --> 00:07:14,380
are approaching the system where we have

122
00:07:20,820 --> 00:07:18,729
a deficit process so we are also in a

123
00:07:26,810 --> 00:07:20,830
not equilibrium position in visible

124
00:07:28,850 --> 00:07:26,820
alumina condition and the diffusion is

125
00:07:33,810 --> 00:07:28,860
[Music]

126
00:07:36,390 --> 00:07:33,820
guided by the the chemical potential

127
00:07:41,070 --> 00:07:36,400
gradient is given by the chemical

128
00:07:44,969 --> 00:07:41,080
potential gradient so the chemical

129
00:07:47,999 --> 00:07:44,979
potential gradient produces the loading

130
00:07:51,529 --> 00:07:48,009
and the loading is characterized by a

131
00:07:54,450 --> 00:07:51,539
concentration gradient I tried to

132
00:08:01,260 --> 00:07:54,460
schematize the system this the the the

133
00:08:03,390 --> 00:08:01,270
picture is our sample and on the

134
00:08:06,149 --> 00:08:03,400
external edge on the left side we have

135
00:08:08,790 --> 00:08:06,159
the maximum concentration value so the

136
00:08:11,820 --> 00:08:08,800
lattice is elongated and the larger the

137
00:08:15,240 --> 00:08:11,830
concentration the larger the elongation

138
00:08:17,939 --> 00:08:15,250

of the of the sample so that the region

139
00:08:21,029 --> 00:08:17,949
that are at lower concentration are

140
00:08:24,180 --> 00:08:21,039
producing a compression stress on the

141
00:08:26,990 --> 00:08:24,190
regions that are at larger hydrogen

142
00:08:30,480 --> 00:08:27,000
concentration so chemical potential is

143
00:08:33,800 --> 00:08:30,490
modified because in additional terms

144
00:08:36,360 --> 00:08:33,810
turns out that is due to the

145
00:08:38,670 --> 00:08:36,370
contribution of the force field so are

146
00:08:43,319 --> 00:08:38,680
the force fields that are able to modify

147
00:08:47,250 --> 00:08:43,329
the free energy of the system so such a

148
00:08:51,090 --> 00:08:47,260
turn is given by the product between the

149
00:08:55,290 --> 00:08:51,100
volume molar volume of the solute times

150
00:08:57,190 --> 00:08:55,300
the trace of the stress tensor and in

151
00:09:00,250 --> 00:08:57,200
this condition with some this guy

152
00:09:03,970 --> 00:09:00,260
the algebra we can demonstrate that the

153
00:09:07,030 --> 00:09:03,980
flux equation is not the Fijian one that

154
00:09:09,400 --> 00:09:07,040
is described just by the first term in

155
00:09:13,350 --> 00:09:09,410
the brackets but there is an additional

156
00:09:17,860 --> 00:09:13,360
terms that is containing the stress and

157
00:09:21,270 --> 00:09:17,870
we can realize that even if we're the

158
00:09:25,630 --> 00:09:21,280
very strong concentration gradient the

159
00:09:28,330 --> 00:09:25,640
the difference in in the bracket can be

160
00:09:30,850 --> 00:09:28,340
zero if we have an appropriate value of

161
00:09:33,370 --> 00:09:30,860
the stress so we can have zero flux

162
00:09:37,450 --> 00:09:33,380
despite we have a strong concentration

163
00:09:42,400 --> 00:09:37,460

gradient and this is limiting our our

164
00:09:46,360 --> 00:09:42,410
loading if we use in differential mass

165
00:09:50,440 --> 00:09:46,370
balance such an expression for the flux

166
00:09:53,170 --> 00:09:50,450
we arrive at the not linear mass

167
00:09:55,960 --> 00:09:53,180
transfer equation described by the

168
00:10:00,340 --> 00:09:55,970
relationship at the bottom of the slides

169
00:10:05,770 --> 00:10:00,350
and I published this paper many years

170
00:10:09,460 --> 00:10:05,780
ago beyond physical therapy so we have

171
00:10:12,840 --> 00:10:09,470
also to work with mass transfer at the

172
00:10:16,240 --> 00:10:12,850
grain grain boundary system and this

173
00:10:18,940 --> 00:10:16,250
process is well described by the two

174
00:10:23,610 --> 00:10:18,950
equation differential equation you can

175
00:10:26,530 --> 00:10:23,620
see on the screen and fortunately this

176
00:10:30,390 --> 00:10:26,540
system of differential equation as a

177
00:10:36,280 --> 00:10:30,400
closed form solution and we can identify

178
00:10:41,980 --> 00:10:36,290
that this solution is strongly affected

179
00:10:44,160 --> 00:10:41,990
by the product between the dimension of

180
00:10:48,370 --> 00:10:44,170
the grain boundary and the diffusion

181
00:10:50,860 --> 00:10:48,380
into the into the grain boundary so the

182
00:10:54,370 --> 00:10:50,870
larger dot product the better the

183
00:10:57,730 --> 00:10:54,380
loading so if we apply the model to our

184
00:11:00,670 --> 00:10:57,740
system we can see that if into the

185
00:11:04,720 --> 00:11:00,680
material we don't have a significant or

186
00:11:07,650 --> 00:11:04,730
a very large stress field we have a

187
00:11:09,960 --> 00:11:07,660
loading that is sorry

188
00:11:16,360 --> 00:11:09,970

we are the loading

189
00:11:20,190 --> 00:11:16,370
that is nicely described by these

190
00:11:23,019 --> 00:11:20,200
modeling and is reproducing the sample

191
00:11:25,360 --> 00:11:23,029
characterized by a good load we are

192
00:11:27,819 --> 00:11:25,370
going to the maximum and then to this

193
00:11:31,780 --> 00:11:27,829
value that means that we are quite close

194
00:11:34,300 --> 00:11:31,790
to point 95 in atomic fraction if into

195
00:11:38,019 --> 00:11:34,310
the material we have some stress as in

196
00:11:40,660 --> 00:11:38,029
this case the loading is is really

197
00:11:43,720 --> 00:11:40,670
really bad we cannot go much more than

198
00:11:48,970 --> 00:11:43,730
point seven point eight and we are not

199
00:11:54,120 --> 00:11:48,980
into the regime for observing the onset

200
00:12:01,569 --> 00:11:54,130
of the effect this is the model and

201
00:12:04,949 --> 00:12:01,579
experiment so on the basis of this study

202
00:12:09,819 --> 00:12:04,959
we have designed the mythology that is

203
00:12:14,230 --> 00:12:09,829
obtained by making cold rolling of the

204
00:12:17,470 --> 00:12:14,240
sample and then an specific annealing in

205
00:12:20,470 --> 00:12:17,480
the plot you can see that there is an

206
00:12:23,740 --> 00:12:20,480
optimum annealing to add a good loading

207
00:12:27,100 --> 00:12:23,750
so we have the loading versus the

208
00:12:31,260 --> 00:12:27,110
annealing temperature so in general we

209
00:12:33,400 --> 00:12:31,270
annealed our sample around 850 900

210
00:12:36,760 --> 00:12:33,410
centigrade if we have a lower

211
00:12:39,340 --> 00:12:36,770
temperature the loading is less if we

212
00:12:43,600 --> 00:12:39,350
have a larger temperature the load that

213
00:12:46,900 --> 00:12:43,610

the loading is less to because the there

214
00:12:51,550 --> 00:12:46,910
is a relevant effect of the stress

215
00:12:54,100 --> 00:12:51,560
gradient inside the metal it depends on

216
00:12:57,840 --> 00:12:54,110
the size of the grains basically so

217
00:13:02,680 --> 00:12:57,850
let's talk about calorimeter so in our

218
00:13:05,829 --> 00:13:02,690
system we have a closed cell closet cell

219
00:13:08,920 --> 00:13:05,839
ourselves where there is a recombine or

220
00:13:10,540 --> 00:13:08,930
a catalyst that is recombining the gas

221
00:13:13,540 --> 00:13:10,550
that are produced at the by the

222
00:13:17,199 --> 00:13:13,550
electrolysis so I mean deuterium and

223
00:13:21,130 --> 00:13:17,209
oxygen are recombined to the water and

224
00:13:22,930 --> 00:13:21,140
the electronic configuration is realized

225
00:13:26,170 --> 00:13:22,940
with

226
00:13:29,620 --> 00:13:26,180
metric geometry the Palladium cathode is

227
00:13:34,030 --> 00:13:29,630
in the midway between to plan a platinum

228
00:13:37,840 --> 00:13:34,040
anodes of course the cell is equipped

229
00:13:40,720 --> 00:13:37,850
with a pressure sensor just to know if

230
00:13:42,850 --> 00:13:40,730
the catalyst is working or not and to

231
00:13:45,310 --> 00:13:42,860
know if we have some recombining effect

232
00:13:49,000 --> 00:13:45,320
inside that is very important to

233
00:13:54,210 --> 00:13:49,010
understand if the effect is chemistry or

234
00:13:58,150 --> 00:13:54,220
not as I will show you in short all our

235
00:14:02,500 --> 00:13:58,160
system have been properly designed in

236
00:14:07,930 --> 00:14:02,510
order to define the temperature field

237
00:14:11,560 --> 00:14:07,940
and in order to identify the answer of

238
00:14:15,280 --> 00:14:11,570

the system in terms of temperature

239
00:14:17,230 --> 00:14:15,290
changing also thermal hydraulics effect

240
00:14:21,400 --> 00:14:17,240
due to the bubbling into the cell have

241
00:14:24,850 --> 00:14:21,410
been studied in the same way the cut we

242
00:14:28,150 --> 00:14:24,860
have adopted two kind of calorimeters

243
00:14:33,090 --> 00:14:28,160
the first one is mass flow calorimeter

244
00:14:38,410 --> 00:14:33,100
that is based on first principles and is

245
00:14:41,830 --> 00:14:38,420
very precise very accurate very

246
00:14:46,480 --> 00:14:41,840
difficult to be operated but we are

247
00:14:51,750 --> 00:14:46,490
making directly measurement of the

248
00:14:56,260 --> 00:14:51,760
output power if the cell is operated in

249
00:15:00,220 --> 00:14:56,270
constant current the input power for a

250
00:15:03,010 --> 00:15:00,230
closed cell is just the scholar product

251
00:15:06,520 --> 00:15:03,020
between the voltage and the current and

252
00:15:10,060 --> 00:15:06,530
the output power can be estimated on the

253
00:15:12,460 --> 00:15:10,070
basis of the difference of the

254
00:15:15,400 --> 00:15:12,470
temperature of the coolant passing

255
00:15:17,890 --> 00:15:15,410
through the calorimeter times the mass

256
00:15:24,180 --> 00:15:17,900
flow rate times the specific heat of

257
00:15:29,700 --> 00:15:27,000
means of the output power divided by the

258
00:15:32,270 --> 00:15:29,710
efficiency of the calorimeter minus the

259
00:15:35,870 --> 00:15:32,280
input power so very simple

260
00:15:39,270 --> 00:15:35,880
technically the calorimeter is realized

261
00:15:41,430 --> 00:15:39,280
putting the cell inside the vessel

262
00:15:45,990 --> 00:15:41,440
containing a water jacket the water

263
00:15:50,670 --> 00:15:46,000

jacket is cooled by a thermostatic water

264
00:15:53,850 --> 00:15:50,680
coming from a thermostatic bath and the

265
00:15:55,970 --> 00:15:53,860
input temperature and output temperature

266
00:15:59,790 --> 00:15:55,980
of the coolant are measured with two

267
00:16:02,910 --> 00:15:59,800
pt100 thermometers and the mass flow

268
00:16:05,160 --> 00:16:02,920
rate is measured then the control led at

269
00:16:07,290 --> 00:16:05,170
about point you cubic centimetre for

270
00:16:14,520 --> 00:16:07,300
second with an accuracy plus minus 1

271
00:16:17,730 --> 00:16:14,530
percent the other concept is an iso

272
00:16:21,630 --> 00:16:17,740
parabolic calorimeter I mean the output

273
00:16:24,140 --> 00:16:21,640
power is not directly measured we need

274
00:16:26,850 --> 00:16:24,150
the calibration in this case that is not

275
00:16:29,280 --> 00:16:26,860
necessarily required for the mass flow

276
00:16:33,120 --> 00:16:29,290
calorimeter and the calibration allows

277
00:16:37,050 --> 00:16:33,130
us to estimate the output part correlate

278
00:16:39,710 --> 00:16:37,060
the output power with a measurement of a

279
00:16:43,140 --> 00:16:39,720
variable that in the case of this

280
00:16:47,370 --> 00:16:43,150
calorimeter developed by novel research

281
00:16:52,550 --> 00:16:47,380
laboratory the parameter is the voltage

282
00:16:56,820 --> 00:16:52,560
difference between the two pal T cells

283
00:16:58,710 --> 00:16:56,830
one is below the active cell so the cell

284
00:17:02,370 --> 00:16:58,720
while we are doing the experiment the

285
00:17:05,059 --> 00:17:02,380
other one is below a dummy cell that is

286
00:17:11,540 --> 00:17:05,069
just a reference this is a differential

287
00:17:15,600 --> 00:17:11,550
calorimeter so let me show you now

288
00:17:19,530 --> 00:17:15,610

electrodes from the same lot operated

289
00:17:23,699 --> 00:17:19,540
with light water and the water you can

290
00:17:27,750 --> 00:17:23,709
see in the in this plot that the input

291
00:17:30,720 --> 00:17:27,760
power that is the black cube perfectly

292
00:17:33,450 --> 00:17:30,730
overlaps at steady state the output

293
00:17:36,820 --> 00:17:33,460
power that is the red cube and the

294
00:17:39,700 --> 00:17:36,830
integral of both the cubes are given

295
00:17:42,370 --> 00:17:39,710
above so we are the input energy and the

296
00:17:44,860 --> 00:17:42,380
output energy and at the end we have a

297
00:17:47,259 --> 00:17:44,870
difference that is due to the thermal

298
00:17:51,389 --> 00:17:47,269
losses from the calorimeter in this case

299
00:17:56,590 --> 00:17:51,399
2.5% that we cannot completely eliminate

300
00:17:58,710 --> 00:17:56,600
and this is the brother of the sample we

301
00:18:02,889 --> 00:17:58,720
have experiences with light water

302
00:18:05,889 --> 00:18:02,899
treated into the water and you see in

303
00:18:08,740 --> 00:18:05,899
the plot the different green curve is

304
00:18:11,409 --> 00:18:08,750
the difference between the output and

305
00:18:18,460 --> 00:18:11,419
the input power when the effects of

306
00:18:21,610 --> 00:18:18,470
course so also the also the energy cubes

307
00:18:24,970 --> 00:18:21,620
are behaving in a different manner you

308
00:18:27,970 --> 00:18:24,980
see the output energy overlaps the input

309
00:18:30,039 --> 00:18:27,980
power and at the end despite the losses

310
00:18:36,159 --> 00:18:30,049
we are into the calorimeter we have a

311
00:18:38,919 --> 00:18:36,169
energy gain we have tested the

312
00:18:42,070 --> 00:18:38,929
electrodes in other labs this is an

313
00:18:45,210 --> 00:18:42,080

experiment performed by Michael macabre

314
00:18:49,180 --> 00:18:45,220
a pleasure AI with similar sample and

315
00:18:51,639 --> 00:18:49,190
this is an extraordinary excess obtained

316
00:18:54,820 --> 00:18:51,649
at the into energetics Technology

317
00:18:57,370 --> 00:18:54,830
Laboratory with one sample preparator in

318
00:18:59,889 --> 00:18:57,380
Frascati you see the input power was

319
00:19:07,029 --> 00:18:59,899
about one watt and the output to achieve

320
00:19:11,860 --> 00:19:07,039
up to 32 watts is about 3500 percent

321
00:19:16,899 --> 00:19:11,870
excess so we presented these results to

322
00:19:19,629 --> 00:19:16,909
a conference in qo3 and then at the

323
00:19:28,180 --> 00:19:19,639
panel organized by the Department of

324
00:19:31,560 --> 00:19:28,190
Energy in almost qo4 and people staying

325
00:19:35,500 --> 00:19:31,570
at this panel at the opportunity to

326
00:19:39,909 --> 00:19:35,510
study our results for some months and

327
00:19:42,820 --> 00:19:39,919
after that they got a sentence that was

328
00:19:45,220 --> 00:19:42,830
positive the nearly unanimous opinion of

329
00:19:47,470 --> 00:19:45,230
the reviewers was that founding agency

330
00:19:50,670 --> 00:19:47,480
should entertain individual well design

331
00:19:54,450 --> 00:19:50,680
and the proposal for experiments so

332
00:19:56,870 --> 00:19:54,460
after that stamp SSRI in Stanford novel

333
00:19:59,250 --> 00:19:56,880
research laboratory and my Institute

334
00:20:01,770 --> 00:19:59,260
energetics and later University of

335
00:20:04,260 --> 00:20:01,780
Missouri have been involved into a

336
00:20:08,760 --> 00:20:04,270
cooperative revision study for several

337
00:20:10,710 --> 00:20:08,770
years these are some of the results most

338
00:20:16,260 --> 00:20:10,720

most significant results we obtained

339
00:20:19,290 --> 00:20:16,270
during this working time on the left

340
00:20:22,860 --> 00:20:19,300
side you have the comparison between the

341
00:20:25,890 --> 00:20:22,870
output and input power for this L 17

342
00:20:29,190 --> 00:20:25,900
experiment you see the blue line is the

343
00:20:32,970 --> 00:20:29,200
input power the the pink one is the

344
00:20:35,760 --> 00:20:32,980
output output power we had a little

345
00:20:38,130 --> 00:20:35,770
excess is not a bias it's a real little

346
00:20:41,010 --> 00:20:38,140
excess but at once

347
00:20:43,740 --> 00:20:41,020
we had a burst and you see the spike of

348
00:20:45,330 --> 00:20:43,750
power that is correlated with the

349
00:20:49,170 --> 00:20:45,340
increasing of the temperature of the

350
00:20:52,080 --> 00:20:49,180
electrolyte that you can see on this on

351
00:20:56,280 --> 00:20:52,090
this plot here that was measured with a

352
00:20:59,940 --> 00:20:56,290
different instrument after that if you

353
00:21:04,800 --> 00:20:59,950
go down here I mean into the loading

354
00:21:08,610 --> 00:21:04,810
cube you may observe that since we were

355
00:21:12,210 --> 00:21:08,620
on the right side of the are on our zero

356
00:21:14,550 --> 00:21:12,220
plot the reducing of the concentration

357
00:21:17,340 --> 00:21:14,560
means an increasing of the are on our

358
00:21:19,980 --> 00:21:17,350
zero value and this is what is occurring

359
00:21:22,680 --> 00:21:19,990
here so the cathode is deloading because

360
00:21:25,290 --> 00:21:22,690
of the heating of the cathode and as

361
00:21:27,990 --> 00:21:25,300
soon as the loading which was below the

362
00:21:34,830 --> 00:21:28,000
threshold the excess disappeared here

363
00:21:37,640 --> 00:21:34,840

and we had to wait some time to gain

364
00:21:41,850 --> 00:21:37,650
another bus that occurred after

365
00:21:45,150 --> 00:21:41,860
reloading the electrode up to this value

366
00:21:48,990 --> 00:21:45,160
so in this case also the electrolyte

367
00:21:52,980 --> 00:21:49,000
temperature is measured and the bus was

368
00:21:55,680 --> 00:21:52,990
long enough to achieve the more or less

369
00:21:58,500 --> 00:21:55,690
the steady-state of the calorimeter so

370
00:22:01,460 --> 00:21:58,510
it's about 500 percent of the excess you

371
00:22:04,820 --> 00:22:01,470
can observe that the

372
00:22:08,169 --> 00:22:04,830
input power was decreasing during the

373
00:22:12,830 --> 00:22:08,179
excess the reason is very simple we have

374
00:22:16,480 --> 00:22:12,840
a power supply that is a galvano stud so

375
00:22:20,440 --> 00:22:16,490
is designed to maintain the setpoint

376
00:22:24,940 --> 00:22:20,450
current so since the electrolyte is

377
00:22:28,760 --> 00:22:24,950
warming up during the excess power the

378
00:22:31,250 --> 00:22:28,770
electrolyte conductivity increases and

379
00:22:33,830 --> 00:22:31,260
the power supply to maintain the

380
00:22:35,750 --> 00:22:33,840
setpoint current as to reducing the

381
00:22:37,750 --> 00:22:35,760
voltage that means that the input power

382
00:22:41,480 --> 00:22:37,760
is reduced but that's why we have this

383
00:22:44,990 --> 00:22:41,490
going down on the input power so in

384
00:22:48,080 --> 00:22:45,000
practice we were practically we had five

385
00:22:53,299 --> 00:22:48,090
hundred percent access in this case this

386
00:22:55,789 --> 00:22:53,309
was was more robust it was explosive we

387
00:22:58,450 --> 00:22:55,799
had you know the increasing of the

388
00:23:01,520 --> 00:22:58,460

electrolyte temperature and this is the

389
00:23:05,180 --> 00:23:01,530
answer of the mass flow calorimeter and

390
00:23:09,140 --> 00:23:05,190
you see that the the bus stop as soon as

391
00:23:13,310 --> 00:23:09,150
the loading ratio was again below the

392
00:23:16,190 --> 00:23:13,320
threshold value this was not long enough

393
00:23:20,680 --> 00:23:16,200
to have the steady state of the

394
00:23:25,279 --> 00:23:20,690
calorimeter and we had to quote the

395
00:23:27,320 --> 00:23:25,289
excess of power on the basis of the time

396
00:23:29,960 --> 00:23:27,330
constant of the calorimeter first and

397
00:23:36,049 --> 00:23:29,970
then with more complex finite element

398
00:23:39,460 --> 00:23:36,059
calculation it was 7000 percent at the

399
00:23:44,560 --> 00:23:39,470
end of the job might Macabre as

400
00:23:48,140 --> 00:23:44,570
organized these synoptic picture that is

401
00:23:50,630 --> 00:23:48,150
must be read in this way and on the

402
00:23:54,230 --> 00:23:50,640
bottom we have the number of the lots of

403
00:23:57,770 --> 00:23:54,240
palladium that we produce it and in the

404
00:23:59,810 --> 00:23:57,780
ordinates you have the percentage of

405
00:24:03,110 --> 00:23:59,820
excess of power you see that for

406
00:24:07,190 --> 00:24:03,120
instance lot 14 gab one access eighty

407
00:24:12,950 --> 00:24:07,200
percent in an air and qxs 80 percent at

408
00:24:15,270 --> 00:24:12,960
s RI lot 17 gap to access not very high

409
00:24:19,200 --> 00:24:15,280
but to access at s RI to

410
00:24:23,940 --> 00:24:19,210
18% and 500% a tener the one I shown you

411
00:24:26,550 --> 00:24:23,950
before and so on so when a lot of

412
00:24:29,220 --> 00:24:26,560
material was working in one lab was

413
00:24:31,410 --> 00:24:29,230

working also in the other if the lot was

414
00:24:36,360 --> 00:24:31,420
not working in one lab was not working

415
00:24:40,410 --> 00:24:36,370
also into the other and the treatment

416
00:24:44,280 --> 00:24:40,420
was always the same but is very

417
00:24:46,410 --> 00:24:44,290
difficult to to find the right condition

418
00:24:48,690 --> 00:24:46,420
of the material so it's not the effect

419
00:24:50,400 --> 00:24:48,700
that is irreproducible is the material

420
00:24:55,170 --> 00:24:50,410
that is difficult to be reproduce it

421
00:24:59,850 --> 00:24:55,180
with that specific condition so what we

422
00:25:03,000 --> 00:24:59,860
observe during this job I power gain

423
00:25:05,940 --> 00:25:03,010
during the excess no power gain during

424
00:25:08,430 --> 00:25:05,950
the excess or no excess and the

425
00:25:11,220 --> 00:25:08,440
different behavior was related to some

426
00:25:15,080 --> 00:25:11,230
feature of the samples ascribed to the

427
00:25:19,050 --> 00:25:15,090
contaminants that were into the sample

428
00:25:22,410 --> 00:25:19,060
in fact as you can see we have two lot

429
00:25:29,400 --> 00:25:22,420
of raw palladium that we purchased from

430
00:25:32,120 --> 00:25:29,410
the same producer you see that there are

431
00:25:35,420 --> 00:25:32,130
several difference into the distribution

432
00:25:38,820 --> 00:25:35,430
into the concentration of the

433
00:25:42,960 --> 00:25:38,830
contaminants look for instance at

434
00:25:44,870 --> 00:25:42,970
platinum that is not not only is not the

435
00:25:48,450 --> 00:25:44,880
only one that is important but it is

436
00:25:50,910 --> 00:25:48,460
more clear in this in this material we

437
00:25:53,640 --> 00:25:50,920
have about 200 partner millions of

438
00:25:56,400 --> 00:25:53,650

platinum and in the second lot - we have

439
00:25:58,680 --> 00:25:56,410
about 80 partner millions of plotting

440
00:26:01,770 --> 00:25:58,690
and working with the part per millions

441
00:26:05,460 --> 00:26:01,780
is very very very very difficult so the

442
00:26:08,190 --> 00:26:05,470
first lot have up to 60 percent of

443
00:26:11,820 --> 00:26:08,200
reproducibility or larger and excess of

444
00:26:14,550 --> 00:26:11,830
power above 100 percent the second lot

445
00:26:17,040 --> 00:26:14,560
we have a reproducibility that was quite

446
00:26:22,050 --> 00:26:17,050
close to ten percent excess of power

447
00:26:26,400 --> 00:26:22,060
that were not about twenty percent but

448
00:26:29,060 --> 00:26:26,410
if the two materials had this

449
00:26:34,799 --> 00:26:29,070
[Music]

450
00:26:40,740 --> 00:26:34,809
you know name was palladium 99.95

451
00:26:42,810 --> 00:26:40,750
percent we know that contaminants can

452
00:26:46,260 --> 00:26:42,820
have a critical role contaminants may

453
00:26:49,140 --> 00:26:46,270
act on the grain size that is affecting

454
00:26:52,230 --> 00:26:49,150
the stress and mass transfer as I told

455
00:26:54,510 --> 00:26:52,240
you before is working on crystal

456
00:26:57,570 --> 00:26:54,520
orientation because some impurities are

457
00:27:00,180 --> 00:26:57,580
linking preferentially to one plane

458
00:27:02,159 --> 00:27:00,190
during the growing up of the of the

459
00:27:04,110 --> 00:27:02,169
crystal during the annealing so they

460
00:27:06,450 --> 00:27:04,120
controls the orientation of the grains

461
00:27:08,580 --> 00:27:06,460
and coronation of the grains is

462
00:27:12,240 --> 00:27:08,590
controlling the kinetics and double

463
00:27:14,279 --> 00:27:12,250

layer capacitance is also affecting the

464
00:27:15,840 --> 00:27:14,289
grain boundary so the mass transfer at

465
00:27:20,510 --> 00:27:15,850
the grain boundary is controlled by

466
00:27:24,029 --> 00:27:20,520
impurities and is also affecting the

467
00:27:26,970 --> 00:27:24,039
effect of the surface treatment I mean

468
00:27:31,950 --> 00:27:26,980
the chemical etching that we are doing

469
00:27:34,380 --> 00:27:31,960
and we will go more in deep later on

470
00:27:37,169 --> 00:27:34,390
this point so the morphology of the

471
00:27:41,399 --> 00:27:37,179
surface is controlled by the impurities

472
00:27:43,440 --> 00:27:41,409
so these are the two samples one

473
00:27:45,810 --> 00:27:43,450
produces with the first lot the second

474
00:27:49,200 --> 00:27:45,820
one the second lot so you see that the

475
00:27:52,020 --> 00:27:49,210
sides of the grains is different you see

476
00:27:54,210 --> 00:27:52,030
that the orientation of the crystal is

477
00:27:57,960 --> 00:27:54,220
different in the first case in the first

478
00:28:00,840 --> 00:27:57,970
case we have 100 mostly oriented grains

479
00:28:09,120 --> 00:28:00,850
in the second case when mixing the 50

480
00:28:11,370 --> 00:28:09,130
percent 100 101 103 bution of the grain

481
00:28:13,799 --> 00:28:11,380
size you see that our q completely

482
00:28:17,250 --> 00:28:13,809
different materials from my point of

483
00:28:19,140 --> 00:28:17,260
view of course despite the day yet the

484
00:28:24,080 --> 00:28:19,150
same name and they were from the same

485
00:28:29,330 --> 00:28:24,090
producer so this is a strong correlation

486
00:28:35,610 --> 00:28:29,340
and bottom you have the number of lots

487
00:28:38,470 --> 00:28:35,620
red bar means that the lattes produces

488
00:28:41,919 --> 00:28:38,480

an excess of power excess power and

489
00:28:46,539 --> 00:28:41,929
the blue is giving the value of the

490
00:28:49,480 --> 00:28:46,549
ratio between the maximum loading we

491
00:28:52,450 --> 00:28:49,490
achieve it and the current density where

492
00:28:55,570 --> 00:28:52,460
to apply to obtain such a maximum load

493
00:28:58,030 --> 00:28:55,580
so as you can see there is the fare sold

494
00:29:03,130 --> 00:28:58,040
below that threshold we don't have any

495
00:29:05,799 --> 00:29:03,140
access width so the larger the the

496
00:29:08,860 --> 00:29:05,809
easier the loading the the larger the

497
00:29:10,659 --> 00:29:08,870
probability to observe the effect this

498
00:29:12,760 --> 00:29:10,669
is new to the characteristic of the

499
00:29:14,770 --> 00:29:12,770
material is due to the probability to

500
00:29:17,919 --> 00:29:14,780
the mass transfer at the grain boundary

501
00:29:20,350 --> 00:29:17,929
so again we need to control this

502
00:29:22,659 --> 00:29:20,360
property of the material since it's a

503
00:29:24,909 --> 00:29:22,669
resonant effect if I move from the

504
00:29:27,490 --> 00:29:24,919
resonance condition maybe working a

505
00:29:30,549 --> 00:29:27,500
tiger current to achieving an Uyghur

506
00:29:32,650 --> 00:29:30,559
loading maybe I go outside the windows

507
00:29:40,630 --> 00:29:32,660
of parameters I need to obtain the

508
00:29:42,850 --> 00:29:40,640
excess so the identified condition

509
00:29:45,390 --> 00:29:42,860
appropriate metallurgy to achieve a good

510
00:29:48,730 --> 00:29:45,400
loading and answered the mass transfer

511
00:29:52,270 --> 00:29:48,740
for palladium for palladium be careful

512
00:29:57,190 --> 00:29:52,280
one mostly oriented material and

513
00:30:00,669 --> 00:29:57,200

appropriate surface morphology so we

514
00:30:03,400 --> 00:30:00,679
have seen that contaminants can affect

515
00:30:09,060 --> 00:30:03,410
the crystal orientation can affect also

516
00:30:12,820 --> 00:30:09,070
the the the grain size but are also

517
00:30:16,270 --> 00:30:12,830
affecting the status of the surface so

518
00:30:19,390 --> 00:30:16,280
we we have studied the surface in terms

519
00:30:22,390 --> 00:30:19,400
of the marriage figure and we identify

520
00:30:25,539 --> 00:30:22,400
these figures as the power spectral

521
00:30:27,940 --> 00:30:25,549
density function of the surface I mean

522
00:30:34,419 --> 00:30:27,950
the score module of the Fourier

523
00:30:36,940 --> 00:30:34,429
transform of the roughness the simple

524
00:30:42,169 --> 00:30:36,950
example power spectral density is

525
00:30:48,350 --> 00:30:46,340
a periodicity is reproducible in this

526
00:30:51,889 --> 00:30:48,360
case as you can see we have Q

527
00:30:54,320 --> 00:30:51,899
periodicity the one the first one is a

528
00:30:57,289 --> 00:30:54,330
frequency periodicity and the second one

529
00:30:59,930 --> 00:30:57,299
is this channel that is a low frequency

530
00:31:01,909 --> 00:30:59,940
periodicity so this material is

531
00:31:04,840 --> 00:31:01,919
characterized by a power spectral

532
00:31:11,440 --> 00:31:04,850
density with two peaks in case of a sign

533
00:31:15,320 --> 00:31:11,450
like surface we have one tick pounding

534
00:31:17,869 --> 00:31:15,330
okay this is the material giving the

535
00:31:20,930 --> 00:31:17,879
large axis of power and you see the

536
00:31:24,080 --> 00:31:20,940
power spectral density achieving a value

537
00:31:27,649 --> 00:31:24,090
forget the scale spot four point five

538
00:31:30,739 --> 00:31:27,659

the other material have an excess in the

539
00:31:33,950 --> 00:31:30,749
order of two hundred fifty percent and

540
00:31:37,879 --> 00:31:33,960
the value is one close to one point

541
00:31:40,730 --> 00:31:37,889
eight this other sample has a power

542
00:31:44,989 --> 00:31:40,740
spectral density having a value of point

543
00:31:48,379 --> 00:31:44,999
six similar shape the Thunder dumping

544
00:31:51,049 --> 00:31:48,389
shade but lower signal of the power

545
00:31:54,379 --> 00:31:51,059
spectral density and this sample has

546
00:31:59,090 --> 00:31:54,389
given only 25 percent excess this other

547
00:32:01,340 --> 00:31:59,100
sample that is in the picture below on

548
00:32:03,409 --> 00:32:01,350
the left side as a completely flat power

549
00:32:07,190 --> 00:32:03,419
spectral density and was completely

550
00:32:09,470 --> 00:32:07,200
inactive so now what we have to do we

551
00:32:12,350 --> 00:32:09,480
have to play with the contaminants and

552
00:32:15,350 --> 00:32:12,360
this is a very difficult task as to

553
00:32:16,869 --> 00:32:15,360
repair in the engine of an airplane

554
00:32:21,619 --> 00:32:16,879
during the fly

555
00:32:23,989 --> 00:32:21,629
so let's produce an active material so

556
00:32:28,249 --> 00:32:23,999
what we have done we have selected the

557
00:32:32,409 --> 00:32:28,259
material having a 1 0 0 orientation but

558
00:32:35,840 --> 00:32:32,419
not giving an appropriate surface to

559
00:32:38,690 --> 00:32:35,850
obtain the onset of the effect and what

560
00:32:41,330 --> 00:32:38,700
we have done is we dope it the material

561
00:32:44,659 --> 00:32:41,340
with the platinum and there is a

562
00:32:46,999 --> 00:32:44,669
specific reason for doing that if you

563
00:32:50,149 --> 00:32:47,009

make an experiment if you weld the

564
00:32:53,450 --> 00:32:50,159
Platinum to piece to a palladium piece

565
00:32:56,270 --> 00:32:53,460
and put this into the acid you will

566
00:32:58,970 --> 00:32:56,280
observe the hydrogen before

567
00:33:01,760 --> 00:32:58,980
mostly on the platinum because the

568
00:33:05,210 --> 00:33:01,770
potential of hydrogen on platinum is

569
00:33:08,240 --> 00:33:05,220
much less than potential on on palladium

570
00:33:12,890 --> 00:33:08,250
so that if we have platinum dispersed

571
00:33:17,270 --> 00:33:12,900
into the metal each point where we have

572
00:33:20,900 --> 00:33:17,280
a platinum impurity becomes like a

573
00:33:24,170 --> 00:33:20,910
cathodic point and the surround is the

574
00:33:27,710 --> 00:33:24,180
anodic protection so palladium is eroded

575
00:33:30,950 --> 00:33:27,720
around the Platinum impurity is a micro

576
00:33:34,910 --> 00:33:30,960
corrosion problem so doping with

577
00:33:37,400 --> 00:33:34,920
platinum and making the etching this was

578
00:33:40,130 --> 00:33:37,410
resolved with the same material same

579
00:33:43,520 --> 00:33:40,140
treatment and instead of airing this

580
00:33:45,170 --> 00:33:43,530
very flat power spectral density we

581
00:33:48,500 --> 00:33:45,180
obtain at this power spectral density

582
00:33:51,260 --> 00:33:48,510
and this is the result of our

583
00:33:53,960 --> 00:33:51,270
calorimetric measurements so we got an

584
00:33:57,650 --> 00:33:53,970
excess of power not tremendous but

585
00:33:59,930 --> 00:33:57,660
control it is about 50% in this case we

586
00:34:02,870 --> 00:33:59,940
repeated the experiment in the same

587
00:34:06,710 --> 00:34:02,880
manner and we reproduced this this

588
00:34:12,950 --> 00:34:06,720

effect so again modify the surface again

589
00:34:17,570 --> 00:34:12,960
excess power on the basis of this data

590
00:34:19,669 --> 00:34:17,580
NRL decided to produce some law with

591
00:34:22,340 --> 00:34:19,679
platinum and this is a palladium rhodium

592
00:34:24,710 --> 00:34:22,350
alloy ten percent of rhodium ninety

593
00:34:28,159 --> 00:34:24,720
percent per little and you can see the

594
00:34:36,380 --> 00:34:28,169
excess of power produced by this sample

595
00:34:39,050 --> 00:34:36,390
during their experiment we identified

596
00:34:42,649 --> 00:34:39,060
palladium rhodium as a possible

597
00:34:45,770 --> 00:34:42,659
candidate for studying this effect and

598
00:34:49,580 --> 00:34:45,780
we produced also palladium rhodium alloy

599
00:34:52,490 --> 00:34:49,590
but at the beginning as you can see this

600
00:34:55,639 --> 00:34:52,500
material was interesting but the power

601
00:34:58,880 --> 00:34:55,649
spectral density was not significant

602
00:35:02,950 --> 00:34:58,890
from our point of view but we decided to

603
00:35:06,810 --> 00:35:02,960
make the experiment despite this

604
00:35:11,020 --> 00:35:06,820
morphology of the surface was not up

605
00:35:15,580 --> 00:35:11,030
the loading was good the x-ray

606
00:35:18,330 --> 00:35:15,590
defraction x-ray defraction vanilla that

607
00:35:21,130 --> 00:35:18,340
palladium rhodium is captured

608
00:35:27,040 --> 00:35:21,140
crystalline structure but anyway the

609
00:35:30,840 --> 00:35:27,050
loading was appropriate and we have

610
00:35:34,780 --> 00:35:30,850
removed ok the cathodes from the cell

611
00:35:38,830 --> 00:35:34,790
during the excess and we observed that

612
00:35:41,140 --> 00:35:38,840
the surface was completely changed so

613
00:35:45,160 --> 00:35:41,150

giving the proper power spectral density

614
00:35:48,040 --> 00:35:45,170
this was spontaneous so the experiment

615
00:35:50,410 --> 00:35:48,050
was carried out in this way look the

616
00:35:53,350 --> 00:35:50,420
excess power was originated

617
00:35:56,200 --> 00:35:53,360
spontaneously then we inverted the

618
00:35:59,290 --> 00:35:56,210
current in order to see if was a bias of

619
00:36:01,840 --> 00:35:59,300
the calorimeter we D loaded the cathode

620
00:36:04,420 --> 00:36:01,850
and as soon as we have done this the

621
00:36:06,880 --> 00:36:04,430
excess disappeared so it was real the

622
00:36:10,360 --> 00:36:06,890
calorimeter was perfectly working we

623
00:36:15,060 --> 00:36:10,370
reloaded and the excess started the game

624
00:36:21,420 --> 00:36:15,070
and after some time we decided to

625
00:36:26,410 --> 00:36:21,430
perform an impedance spectrometry of the

626
00:36:30,700 --> 00:36:26,420
of the electrode so we perform at the

627
00:36:33,610 --> 00:36:30,710
first spectrometry in this in this point

628
00:36:37,060 --> 00:36:33,620
then we have which said of the excess

629
00:36:40,770 --> 00:36:37,070
and we replicated the the impedance

630
00:36:43,330 --> 00:36:40,780
spectra spectroscopy so it's very

631
00:36:45,910 --> 00:36:43,340
important from my point of view to

632
00:36:49,000 --> 00:36:45,920
highlight that during the excess we had

633
00:36:52,360 --> 00:36:49,010
an electrochemical instability so there

634
00:36:56,200 --> 00:36:52,370
was a fluctuation of the current that is

635
00:37:00,700 --> 00:36:56,210
indicative of a specific mechanism at

636
00:37:04,500 --> 00:37:00,710
the interface so let me show you what

637
00:37:08,260 --> 00:37:04,510
happened this is the study of the in

638
00:37:09,850 --> 00:37:08,270

interface electrochemical interface

639
00:37:12,490 --> 00:37:09,860
electrochemical interface is

640
00:37:14,860 --> 00:37:12,500
characterized by an equivalent circuit

641
00:37:16,839 --> 00:37:14,870
and this is the equivalent circuit when

642
00:37:20,499 --> 00:37:16,849
we don't have any excess

643
00:37:25,680 --> 00:37:20,509
the pictures during the excess is this

644
00:37:29,289 --> 00:37:25,690
one is a completely different system

645
00:37:34,390 --> 00:37:29,299
with a completely different equivalent

646
00:37:36,190 --> 00:37:34,400
secret showing inside the resonator we

647
00:37:39,789 --> 00:37:36,200
have done several measurement of this

648
00:37:44,140 --> 00:37:39,799
and we have seen that the resonator

649
00:37:49,539 --> 00:37:44,150
survives until we apply a strong

650
00:37:53,289 --> 00:37:49,549
perturbation to the system by putting

651
00:37:57,120 --> 00:37:53,299
the current to zero value and after that

652
00:38:03,609 --> 00:37:57,130
the resonator disappeared and the system

653
00:38:05,799 --> 00:38:03,619
was was without any access reapplying

654
00:38:08,200 --> 00:38:05,809
the current again in the right in the

655
00:38:11,200 --> 00:38:08,210
right way we will start at the excess

656
00:38:14,469 --> 00:38:11,210
the important is that the surface of the

657
00:38:16,950 --> 00:38:14,479
samples have specific fusion so you see

658
00:38:23,680 --> 00:38:16,960
the contaminants on the surface this is

659
00:38:28,059 --> 00:38:23,690
aluminum and this is silicon obtained by

660
00:38:30,700 --> 00:38:28,069
headaches analysis we tried to replicate

661
00:38:33,789 --> 00:38:30,710
the experiment with another sample not

662
00:38:36,099 --> 00:38:33,799
adding these contaminants in the surface

663
00:38:38,229 --> 00:38:36,109

and you can see the difference with the

664
00:38:41,529 --> 00:38:38,239
active electrode I have shown you before

665
00:38:44,400 --> 00:38:41,539
so it's a different material and we

666
00:38:47,890 --> 00:38:44,410
don't have any excess in this case after

667
00:38:50,799 --> 00:38:47,900
five Lots working to replicate that

668
00:38:53,559 --> 00:38:50,809
material we obtained that last one with

669
00:38:56,410 --> 00:38:53,569
similar characteristic that was

670
00:38:59,259 --> 00:38:56,420
experiences and gaba gain excess of

671
00:39:00,969 --> 00:38:59,269
power so again the problem is the

672
00:39:04,779 --> 00:39:00,979
reproducibility of the material not the

673
00:39:07,690 --> 00:39:04,789
profitability of the effect so in

674
00:39:10,420 --> 00:39:07,700
conclusion we can say that material

675
00:39:12,549 --> 00:39:10,430
feature related with the occurrence of

676
00:39:14,529 --> 00:39:12,559
the effect have been identified so we

677
00:39:17,910 --> 00:39:14,539
have a loading threshold loading

678
00:39:21,630 --> 00:39:17,920
dynamics grain grain boundary sides

679
00:39:24,609 --> 00:39:21,640
surface morphology crystal orientation

680
00:39:30,220 --> 00:39:24,619
we have identified the specific role of

681
00:39:33,220 --> 00:39:30,230
some contaminants and the in situ

682
00:39:36,400 --> 00:39:33,230
throw chemical impedance spectroscopy as

683
00:39:39,730 --> 00:39:36,410
shown that there is a specific structure

684
00:39:42,840 --> 00:39:39,740
at the interface so we have resonating

685
00:39:46,599 --> 00:39:42,850
the circuits component during the access

686
00:39:49,510 --> 00:39:46,609
so the emerging scenario is revealing us

687
00:39:54,190 --> 00:39:49,520
that there is a specific electrochemical

688
00:39:57,609 --> 00:39:54,200

regime during this effect and we

689
00:40:00,280 --> 00:39:57,619
consider the material status be the key

690
00:40:02,650 --> 00:40:00,290
to observe the effect while material

691
00:40:05,920 --> 00:40:02,660
science is the key to understand it

692
00:40:08,020 --> 00:40:05,930
since some material characteristics are

693
00:40:11,590 --> 00:40:08,030
supporting some process rather than

694
00:40:14,200 --> 00:40:11,600
others in my opinion I think that by

695
00:40:17,650 --> 00:40:14,210
applying the scientific method the

696
00:40:19,750 --> 00:40:17,660
future work should be oriented toward

697
00:40:23,080 --> 00:40:19,760
the definition of the effect rather than

698
00:40:26,740 --> 00:40:23,090
to its demonstration because this work

699
00:40:29,349 --> 00:40:26,750
has been already done for 25 years so

700
00:40:39,809 --> 00:40:29,359
there are many contributors of this work

701
00:40:56,799 --> 00:40:51,400
thank you very much it's wonderful to

702
00:40:58,690 --> 00:40:56,809
see the replicability of this excess

703
00:41:01,059 --> 00:40:58,700
energy which is something I know the the

704
00:41:03,700 --> 00:41:01,069
field has been looking for for many many

705
00:41:08,680 --> 00:41:03,710
years and you're you're finally getting

706
00:41:12,609 --> 00:41:08,690
it and it just seems great where do you

707
00:41:15,339 --> 00:41:12,619
think a theory to explain this will come

708
00:41:19,480 --> 00:41:15,349
from is this a material science theory

709
00:41:21,990 --> 00:41:19,490
is that a quantum theory is do you have

710
00:41:29,859 --> 00:41:22,000
any foundational theory that you like

711
00:41:33,700 --> 00:41:29,869
well we have some theories as I

712
00:41:37,089 --> 00:41:33,710
mentioned at the beginning we are

713
00:41:42,700 --> 00:41:37,099

producing the data that should be the

714
00:41:45,460 --> 00:41:42,710
basis to refine the tails the system is

715
00:41:48,430 --> 00:41:45,470
very complex because you know we have

716
00:41:51,190 --> 00:41:48,440
one region that is one micron thick in

717
00:41:53,260 --> 00:41:51,200
this region where the electrolyte that

718
00:41:56,020 --> 00:41:53,270
is a liquid we are with the bubbles

719
00:41:57,789 --> 00:41:56,030
format by the electrolysis we have the

720
00:41:59,920 --> 00:41:57,799
double layer the electrochemical double

721
00:42:02,140 --> 00:41:59,930
layer that is a statistical system of

722
00:42:04,150 --> 00:42:02,150
charged particles so by definition is a

723
00:42:06,700 --> 00:42:04,160
plasma and then we have the solid state

724
00:42:10,630 --> 00:42:06,710
we have four status of the matter in one

725
00:42:14,559 --> 00:42:10,640
micron so each of them with its physics

726
00:42:19,620 --> 00:42:14,569
all all talking each others and is very

727
00:42:22,120 --> 00:42:19,630
complex to define completely at every

728
00:42:26,950 --> 00:42:22,130
certainly on the basis of what we have

729
00:42:30,849 --> 00:42:26,960
seen what I can say is a an electro

730
00:42:35,349 --> 00:42:30,859
dynamic effect a very intense electro

731
00:42:40,839 --> 00:42:35,359
dynamic effect and how this can act on

732
00:42:43,690 --> 00:42:40,849
the nuclei must be better defined so we

733
00:42:46,829 --> 00:42:43,700
have many tables so me several times

734
00:42:50,799 --> 00:42:46,839
that are oriented in this way but I

735
00:42:53,410 --> 00:42:50,809
think we need more data to to do that

736
00:42:57,789 --> 00:42:53,420
talking about reproducibility

737
00:43:01,319 --> 00:42:57,799
to obtain working the lot we are to make

738
00:43:05,499 --> 00:43:01,329

a long job so if we make me be let's say

739
00:43:12,130 --> 00:43:05,509
2025 experiment for year we can expect

740
00:43:15,880 --> 00:43:12,140
12 to 3 X s so this is our possibility

741
00:43:19,599 --> 00:43:15,890
we are few people and I think this is

742
00:43:23,019 --> 00:43:19,609
the big limit of this discipline we

743
00:43:28,779 --> 00:43:23,029
don't have what we exactly meet in terms

744
00:43:31,660 --> 00:43:28,789
of intelligence in terms of manpower and

745
00:43:34,329 --> 00:43:31,670
also on instruments that believe me have

746
00:43:36,130 --> 00:43:34,339
to be the status of the art instrument I

747
00:43:37,959 --> 00:43:36,140
would like for instance to make the

748
00:43:40,390 --> 00:43:37,969
measurement inside the grain boundary to

749
00:43:42,370 --> 00:43:40,400
know exactly what we have there but for

750
00:43:46,120 --> 00:43:42,380
doing that we need in high resolution

751
00:43:51,069 --> 00:43:46,130
logic for 40 nanometers resolution and

752
00:43:55,150 --> 00:43:51,079
this is not simple to air so for us so

753
00:43:57,249 --> 00:43:55,160
and so on okay all right thank you so

754
00:44:00,189 --> 00:43:57,259
much for this wonderful talk I think you

755
00:44:02,739 --> 00:44:00,199
guys did excellent science but what

756
00:44:07,749 --> 00:44:02,749
struck me is having followed cold fusion

757
00:44:11,439 --> 00:44:07,759
or lower near low nuclear reactions as

758
00:44:15,400 --> 00:44:11,449
it's called now 25 years ago I am

759
00:44:17,949 --> 00:44:15,410
surprised that you have not gotten more

760
00:44:19,150 --> 00:44:17,959
funding or support and I'm surprised

761
00:44:22,029 --> 00:44:19,160
that this is not done at every

762
00:44:24,549 --> 00:44:22,039
University I mean your your presentation

763
00:44:26,769 --> 00:44:24,559

shows there is no question anymore

764
00:44:29,469 --> 00:44:26,779
whether there is an effect or not so

765
00:44:33,789 --> 00:44:29,479
obviously we need to throw all we have

766
00:44:39,219 --> 00:44:33,799
at this effect how so my question is

767
00:44:44,229 --> 00:44:39,229
this why has it taken 25 years and what

768
00:44:47,709 --> 00:44:44,239
is the future of this well thanks for

769
00:44:55,660 --> 00:44:47,719
meeting this question I think that we

770
00:45:04,600 --> 00:44:55,670
can answer both me and Mike I do believe

771
00:45:08,260 --> 00:45:04,610
that this discipline had a bad starting

772
00:45:13,000 --> 00:45:08,270
so the scientific community had not the

773
00:45:17,350 --> 00:45:13,010
right position to approach this study

774
00:45:22,930 --> 00:45:17,360
and this had an effect for the following

775
00:45:26,530 --> 00:45:22,940
so papers are typically not accepted in

776
00:45:31,290 --> 00:45:26,540
the magazine we don't have any chance to

777
00:45:35,980 --> 00:45:31,300
offer job opportunity to young people so

778
00:45:39,490 --> 00:45:35,990
this is an I risk job for people that

779
00:45:44,830 --> 00:45:39,500
are starting young so and I think this

780
00:45:48,610 --> 00:45:44,840
is the worst situation that we may have

781
00:45:51,760 --> 00:45:48,620
in approaching the discipline because

782
00:45:57,730 --> 00:45:51,770
the Youngs can guarantee the future we

783
00:46:00,970 --> 00:45:57,740
don't have this guarantee at all so what

784
00:46:03,220 --> 00:46:00,980
we can do i I don't know I think we are

785
00:46:06,460 --> 00:46:03,230
demonstrated that the effect is real as

786
00:46:09,160 --> 00:46:06,470
a very strong correlation is not a

787
00:46:12,550 --> 00:46:09,170
chemical effect in the last x-axis I

788
00:46:15,550 --> 00:46:12,560

shown you we had an energy gain that was

789
00:46:17,620 --> 00:46:15,560
50 times larger than the largest

790
00:46:21,940 --> 00:46:17,630
chemical effect that we can have in that

791
00:46:27,070 --> 00:46:21,950
cell so that we have much more than that

792
00:46:29,770 --> 00:46:27,080
I had no time to show you but so for our

793
00:46:34,420 --> 00:46:29,780
level of knowledge we can consider that

794
00:46:36,430 --> 00:46:34,430
this is a nuclear effect we have some

795
00:46:40,780 --> 00:46:36,440
data that are indicative in that

796
00:46:45,100 --> 00:46:40,790
direction but for making a sentence in

797
00:46:50,170 --> 00:46:45,110
this way we should replicate a joint

798
00:46:51,790 --> 00:46:50,180
research program organized as the one we

799
00:46:55,330 --> 00:46:51,800
have done for demonstrating that the

800
00:46:58,240 --> 00:46:55,340
access to it is real in terms of search

801
00:47:01,270 --> 00:46:58,250
for new garages this is important so

802
00:47:03,180 --> 00:47:01,280
with well organized research

803
00:47:06,970 --> 00:47:03,190
institutions working together

804
00:47:09,640 --> 00:47:06,980
overlapping their results making mutual

805
00:47:13,150 --> 00:47:09,650
check on results I don't think there is

806
00:47:17,799 --> 00:47:13,160
any other way to approach the matter

807
00:47:22,630 --> 00:47:17,809
with the scientific method but we need

808
00:47:25,779 --> 00:47:22,640
a minimal support for going on thank you

809
00:47:27,759 --> 00:47:25,789
just a question I noticed you said when

810
00:47:30,269 --> 00:47:27,769
you pulled the cathode out there was

811
00:47:33,039 --> 00:47:30,279
some damage to it or it had been

812
00:47:34,929 --> 00:47:33,049
impacted or affected and I know that

813
00:47:37,359 --> 00:47:34,939

fusion in the past has always been

814
00:47:39,429 --> 00:47:37,369
issues regarding the containment vessels

815
00:47:41,650 --> 00:47:39,439
or whatever being affected by the

816
00:47:45,609 --> 00:47:41,660
process itself and does this become a

817
00:47:48,039 --> 00:47:45,619
real future problem in that you're

818
00:47:56,410 --> 00:47:48,049
constantly having to deal with that sort

819
00:47:57,699 --> 00:47:56,420
of effect okay I shown you that during

820
00:48:00,400 --> 00:47:57,709
that experiment

821
00:48:02,229 --> 00:48:00,410
I removed the electrode from the cell

822
00:48:04,660 --> 00:48:02,239
without uh switching off the power

823
00:48:07,449 --> 00:48:04,670
supply so to maintain the surface of the

824
00:48:10,749 --> 00:48:07,459
electrode as was during the excess from

825
00:48:14,709 --> 00:48:10,759
that experiment we have collected a lot

826
00:48:17,529 --> 00:48:14,719
of information status of the surface

827
00:48:20,380 --> 00:48:17,539
status of the interface in terms of

828
00:48:24,009 --> 00:48:20,390
equivalent electric secret we have

829
00:48:26,679 --> 00:48:24,019
observed the growing of these nano

830
00:48:28,660 --> 00:48:26,689
fractures on the surface force and nano

831
00:48:33,699 --> 00:48:28,670
structures on the surface that are

832
00:48:37,449 --> 00:48:33,709
giving us information on the possible

833
00:48:42,039 --> 00:48:37,459
mechanism that we can add there so this

834
00:48:44,859 --> 00:48:42,049
was done and of course sometime we are

835
00:48:48,009 --> 00:48:44,869
able to control it I mean to produce a

836
00:48:50,979 --> 00:48:48,019
material that as these fissures as soon

837
00:48:54,249 --> 00:48:50,989
as is installed into the electrochemical

838
00:48:58,029 --> 00:48:54,259

cell sometime we have to wait that this

839
00:48:59,609 --> 00:48:58,039
condition is created because into the

840
00:49:03,160 --> 00:48:59,619
system there are the right ingredients

841
00:49:06,759 --> 00:49:03,170
but to have a control at level of part

842
00:49:10,569 --> 00:49:06,769
of a million's we we need a much better

843
00:49:13,029 --> 00:49:10,579
approach so the best way to go on if we

844
00:49:15,249 --> 00:49:13,039
decide to continue this research instead

845
00:49:17,469 --> 00:49:15,259
of stopping it because I I see that

846
00:49:19,660 --> 00:49:17,479
there is nonzero probability to stop

847
00:49:22,059 --> 00:49:19,670
such a research is to a very well

848
00:49:25,959 --> 00:49:22,069
conceived at the research international

849
00:49:29,660 --> 00:49:25,969
research project shared between several

850
00:49:32,359 --> 00:49:29,670
counties and with the very precise

851
00:49:37,640 --> 00:49:32,369
that that can be material science no

852
00:49:40,910 --> 00:49:37,650
garages Vittorio thank you I got the

853
00:49:43,819 --> 00:49:40,920
impression that resonant frequency of

854
00:49:46,640 --> 00:49:43,829
the electrolyte current was a critical

855
00:49:50,420 --> 00:49:46,650
factor in your success and you may have

856
00:49:53,450 --> 00:49:50,430
shown data on those frequencies that I

857
00:49:56,260 --> 00:49:53,460
missed is my understanding correct and

858
00:50:00,819 --> 00:49:56,270
can you review that for us again I

859
00:50:04,069 --> 00:50:00,829
mentioned at the beginning about

860
00:50:06,559 --> 00:50:04,079
electromagnetic signals so we have

861
00:50:09,650 --> 00:50:06,569
preliminary measurement of radio

862
00:50:13,059 --> 00:50:09,660
frequency emission from that system

863
00:50:16,930 --> 00:50:13,069

certainly we have the frequency

864
00:50:20,530 --> 00:50:16,940
identified by the electro chemical

865
00:50:24,859 --> 00:50:20,540
instrumentation but we have also either

866
00:50:27,140 --> 00:50:24,869
frequencies and to extract signal at a

867
00:50:31,370 --> 00:50:27,150
frequency from an electrochemical cell

868
00:50:35,589 --> 00:50:31,380
is not a simple task again we we need

869
00:50:39,400 --> 00:50:35,599
the support for doing that we are in

870
00:50:44,150 --> 00:50:39,410
cooperation with National Instruments to

871
00:50:47,960 --> 00:50:44,160
try to understand which one are the the

872
00:50:52,099 --> 00:50:47,970
most appropriate measurement instruments

873
00:50:55,180 --> 00:50:52,109
to be applied for and if in case is

874
00:50:57,920 --> 00:50:55,190
possible to design specific

875
00:51:00,680 --> 00:50:57,930
instrumentation for for doing that but

876
00:51:05,150 --> 00:51:00,690
as I told you this can be done within a

877
00:51:08,650 --> 00:51:05,160
general research project that at the

878
00:51:14,510 --> 00:51:11,270
thank you do you have any view on

879
00:51:19,520 --> 00:51:14,520
Rossi's ecad energy catalyzer

880
00:51:23,059 --> 00:51:19,530
learner device well honestly I don't

881
00:51:27,170 --> 00:51:23,069
know too much with the exception of what

882
00:51:31,819 --> 00:51:27,180
is available on on the web or into the

883
00:51:34,880 --> 00:51:31,829
literature my Institute is one of the

884
00:51:39,140 --> 00:51:34,890
largest hot fusion Institute in Europe

885
00:51:44,090 --> 00:51:39,150
is Frascati Research Center and I am

886
00:51:53,340 --> 00:51:49,859
so our task is to try to identify the

887
00:51:57,510 --> 00:51:53,350
mechanism Rossi is working for producing

888
00:52:06,060 --> 00:51:57,520

a commercial device so I don't have any

889
00:52:07,470 --> 00:52:06,070
elements from them to um we presented

890
00:52:10,470 --> 00:52:07,480
I'm not sure if you were here yesterday

891
00:52:13,200 --> 00:52:10,480
morning about water and about a special

892
00:52:15,870 --> 00:52:13,210
zone interesting professor thank you

893
00:52:17,790 --> 00:52:15,880
okay so maybe it's interesting for you

894
00:52:19,920 --> 00:52:17,800
because we studied what happens next to

895
00:52:23,310 --> 00:52:19,930
platinum and gold and a little bit

896
00:52:27,200 --> 00:52:23,320
palladium to our surprise we found these

897
00:52:29,820 --> 00:52:27,210
zones existing next to those metals and

898
00:52:31,950 --> 00:52:29,830
there is apparently a separation of

899
00:52:33,570 --> 00:52:31,960
charge between the exclusion zone and

900
00:52:36,960 --> 00:52:33,580
the exclusions don't right next to it

901
00:52:39,480 --> 00:52:36,970
and therefore I wonder if first of all

902
00:52:43,050 --> 00:52:39,490
whether that might be relevant to some

903
00:52:47,910 --> 00:52:43,060
of the findings that that you mentioned

904
00:52:50,940 --> 00:52:47,920
and the second maybe I don't know but in

905
00:52:53,460 --> 00:52:50,950
in the case of these exclusion zones we

906
00:52:55,590 --> 00:52:53,470
show that the energy for creating them

907
00:52:58,020 --> 00:52:55,600
comes from the environment so I'm

908
00:53:00,540 --> 00:52:58,030
wondering if there are some relevance of

909
00:53:03,570 --> 00:53:00,550
our stuff to your stuff is it possible

910
00:53:06,200 --> 00:53:03,580
that the excess energy is really energy

911
00:53:16,020 --> 00:53:06,210
that coming from the environment

912
00:53:19,920 --> 00:53:16,030
let me ask as I mentioned at the

913
00:53:22,740 --> 00:53:19,930

beginning in this experiment if we

914
00:53:26,010 --> 00:53:22,750
consider the electrode the bull

915
00:53:31,710 --> 00:53:26,020
electrode without any distinction

916
00:53:34,950 --> 00:53:31,720
between palladium and deuterium the the

917
00:53:37,530 --> 00:53:34,960
energy of the chemical bond should have

918
00:53:41,010 --> 00:53:37,540
been in the order of 10,000 electron

919
00:53:43,080 --> 00:53:41,020
volts for giving an excess like this we

920
00:53:45,270 --> 00:53:43,090
can also imagine that for some reason we

921
00:53:48,450 --> 00:53:45,280
are accumulating energy into the

922
00:53:51,270 --> 00:53:48,460
cathodes at very low power let's say 1

923
00:53:54,770 --> 00:53:51,280
milli watt that our calorimeter is

924
00:53:56,840 --> 00:53:54,780
unable to reach for amount

925
00:54:00,020 --> 00:53:56,850
and then for some reason for instance as

926
00:54:02,990 --> 00:54:00,030
is happening into the graphite nuclear

927
00:54:05,000 --> 00:54:03,000
power station we could have some

928
00:54:09,260 --> 00:54:05,010
mechanism like the vignette effect and

929
00:54:12,140 --> 00:54:09,270
these heat energy is released at once so

930
00:54:14,570 --> 00:54:12,150
in that case we have a releasing of a

931
00:54:17,390 --> 00:54:14,580
significant amount of energy in a very

932
00:54:20,060 --> 00:54:17,400
short time and this will give a big

933
00:54:22,880 --> 00:54:20,070
power that we can see with the

934
00:54:26,630 --> 00:54:22,890
calorimeter but also in this case the

935
00:54:29,120 --> 00:54:26,640
integral must be you know consistent

936
00:54:31,970 --> 00:54:29,130
with the energy of the chemical bond you

937
00:54:34,850 --> 00:54:31,980
could observe that this could be energy

938
00:54:37,520 --> 00:54:34,860

accumulated into the liquid I agree with

939
00:54:39,920 --> 00:54:37,530
you but assuming that we have a so

940
00:54:42,440 --> 00:54:39,930
strong guy so topic effect that these

941
00:54:46,670 --> 00:54:42,450
energies accumulated into the Edie water

942
00:54:49,400 --> 00:54:46,680
we cannot explain why with a small

943
00:54:52,580 --> 00:54:49,410
amount of EB water we can have access

944
00:54:55,160 --> 00:54:52,590
much larger than with the large amount

945
00:54:58,910 --> 00:54:55,170
of EB water so this is in conflict with

946
00:55:01,580 --> 00:54:58,920
the evidence and another point that I

947
00:55:03,920 --> 00:55:01,590
have to answer is we don't have any

948
00:55:05,650 --> 00:55:03,930
reaction any chemical reaction in the

949
00:55:07,490 --> 00:55:05,660
cell we don't have product the cell

950
00:55:11,510 --> 00:55:07,500
fortunately for us because it's

951
00:55:13,310 --> 00:55:11,520
expensive is use at four years so the

952
00:55:16,070 --> 00:55:13,320
materials are conserved

953
00:55:18,770 --> 00:55:16,080
so this is what I can tell you just on

954
00:55:21,490 --> 00:55:18,780
the basis of the observations Thank You

955
00:55:24,780 --> 00:55:21,500
professor Pollak

956
00:55:27,600 --> 00:55:24,790
fascinating thank you doctor

957
00:55:29,240 --> 00:55:27,610
[Applause]

958
00:55:30,220 --> 00:55:29,250
[Music]