#	Question	Asker Name
1	Dear Panelist,What is your comment on refrigeration absorption method, which uses the heat from solar energy for the system. Does it still have a prospect in the current & future, or no? What is the bottle neck of the implementation?Thank you.	Achmad Rofi Irsyad
2	I would like to know more about atmospheric window (8-13 micron), do you mind basic principles of radiation cooling factors affecting radiative cooling and how to control that?	Sujoy Kumar Saha
3	What are the factors affecting radiative cooling and how to control that?	Sujoy Kumar Saha
4	What is the current approach to maximize radiative cooling in cloudy days?	Qiye Zheng
5	should we decide to simulate the phenomenon, applicable eqns please and the bc abd ic, assuming a transient situation. What would be the suggested numerical method to solve the eqn?	Sujoy Kumar Saha
6	Could I ask if it is actually better to decrease energy consumptions? I think using these materials for cooling is bad for keeping temperature at night or in winter, and we need to operate heaters more at nights or in winter, which also use energy and emit greenhouse gas emissions.	Wonjae Choi
7	How far is it to commercialize these radiation cooling materials? What is the status for radi-cool and sky-cool? What is the current bottle neck?	Ze Zhang
8	What's the cost difference between white and super cool roof?	Muhammad Taha Manzoor

9	What is the durability of these materials?	Daniel Boman
10	Is it possible to apply this new material as a paint?	Diego Ceotto
11	If a shade were put over the shingled roof, how would temperature be in the room compare to the metamaterial roof?	Adam Wilson, US Army Research Laboratory
12	May I ask a question to Ronggui Yang about heat storage	Sultan Danish
13	Would you please talk about the cost of these materials?	Sumit
14	Did you study aging of the materials under outdoor conditions?	beysens
15	How about roads? Roads are black and heat up very quickly. We can develop a hard, reliable material to coat roads for radiative cooling?	Muhammad Taha Manzoor
16	Thank you for your talk. On the contrary to a positive illumination such as in solar heating, in a radiative cooling process infrared light at oblique angle should play a major role too. It seems there is room to improve cooling technology by an appropriate design of materials at oblique incidence. What about the efforts made in this direction?	Philippe Ben-Abdallah

17	does smog have an impact on the application of radi-cool (especially concerning summer-smog)	Anonymous Attendee
18	Question from Xiao Yan, UIUC: Hi Prof. Yang, do you think there is any room for improvement of the current radiation cooling technology, in terms of the thermal performance and its implementation? What is the current limit if there is? Thank you!	Xiao
19	How can we use these materials as building materials? In winter it may increase heating budget. Can we change cooling depending on season?	Bathina Chaitanya
21	Does it help Air Conditioner Efficiency?	Daniel Karpf
22	As you have mentioned, the atmosphere is especially transparent for 8um-13um light, and we know that wave length mainly depends on the surface temperature of an object, so how much does the 8-13um light reflections contribute to the total cooling power? and will the material still be efficient under extreme cold/hot circumstances?	Jiadong Sun
23	Suggest a topic that covers radiate heat	Daniel Karpf
24	How about the durability of the polymer metamaterials? Lifetime? Any performance deterioration over time?	Tengfei Luo

27	Hi Ronggui, we appreciate your nice presentation today! I have 2 questions: 1. What is your material's operation temperature range? Can it be adapted to high temp or cryo applications? 2. What does the surface roughness look like, and is it resilient against weathering and aging? Solar absorptivity can increase with sub-micron roughness features. Thanks for answering my questions! -Hot in Texas, Richard	Zihao Zhang
28	Longnan Li (Postdoc,UIUC) Q1. What is the bottleneck of current radiative cooling technology when we use it in real world? Q2. How is the thermal stability of current polymer based radiative materials in high temperature applications?	Longnan Li
29	Ronggui, thank you for your great talk as usual. I found many people want to try your technology in simple applications. For the house roof application, you have mentioned the cooling have to be stopped in winter. Is there any practical way?	Shigeo Maruyama
31	What is proven stability (or degradation) of these materials?	Varun Mehra
33	Do you expect emissivity, as picked up by these IR camera temperature measurements, to be different between your metamaterial and surfaces measured to be hotter? If so, are you accounting for that in your measurements?	Adam Wilson, US Army Research Laboratory
35	are there any cycling longevity issues for those metamaterial?	regis.debord

36	Thank you for your talk. On the contrary to a positive illumination such as in solar heating, in a radiative cooling process infrared light at oblique angle should play a major role. It seems there is room to improve cooling technology by an appropriate design of materials at oblique incidence. What about the efforts made in this direction?	Philippe Ben-Abdallah
38	IMHO, it will require a lot of area to apply for the power plant dry cooling. For the building, it will be embedded with the building envelope and consume more energy	Achmad Rofi Irsyad
39	in the container experiment example, why don't we observe cooling effect during the night with meta surface? thanks	Xiaofeng GUO
40	How about the long-term performance?	Paul Wang
41	How much is the cost to make the radiative material?	秀彰 手嶋
42	How does the integration of the radiative cooling tech deal with winter heating penalty?	Qiye Zheng
43	It will be great to address the potential of rad cool in agriculture sector, thanks.	TJ Zhang
44	1. Switchable optical properties to control the on and off during summer and winter? 2. In thermal liquid, the temperature should become same as environment, right?	Anonymous Attendee

45	Can you tell something about the so-called thermoradiative cell (also referred as negative illumination cells)?	Bruno Lorenzi
46	Can we get PPT of this presentation and how to find this video on YouTube	Anonymous Attendee
47	Could you emphasize again what's the requirement or challenge to design a good radiative cooling structure or materials?	Ziyang Ye
48	How does performance change with humidity given that water vapor absorbs in the window where we emit to space?	Akanksha Menon
49	Why isn't the radiative cooling technology discussed not widely used yet?	Divya Chalise
50	Sustainable agriculture usage is limited to greenhouse? or there could be other applications too?	Anonymous Attendee
51	what about the life cycle analysis of the radicool material? how much energy is spent on making the material and can you compare this with the energy savings?	Arjun Thangaraj R
52	I'm curious about the tradeoffs of putting solar panels on roofs vs. adding different coatings to enhance thermal characteristics of buildings. What are the tradeoffs in terms of energy and cost, and which is better?	Anonymous Attendee
53	How to cool the building in summer and warm it in winter by using the same roof?	Jun Wang

54	Can we absorb heat from cement walls?	Tejas Mahajani
55	Thanks for the inspiring talk! I would like to ask information about the durability of the metamaterial radiative cooling layers?	Linxiao Zhu
56	What is the theoretical limit of radiative cooling in terms of cooling power? Would we ever be able to achieve values to enable refrigeration?	Anonymous Attendee
57	Also for the urban heat island effect, with buildings of different heights, wouldn't the view factor be impacted and limit how much energy can be radiated into space?	Akanksha Menon
58	How about the long-term performance of the material?	Paul Wang
59	Just a comment - a brilliant idea, just opposite to spectral tuning for solar collector, but has lots of new applications. Thanks.	zxguo
60	The air conditioning applications need to consider the increase in cost of heating during cold weather, so these need a switch between heating and cooling.	Heremans.1
61	Can we accelerate the radiative heat dissipation from cement walls?	Tejas Mahajani
62	The power plant cooling applications don't need a thermal switch. Isn't that a major advantage?	Heremans.1

63	how does the cost of radiative cooling compare to other solutions? does the save in the consumption of electricity for air conditioning pays off the cost of the coating?	Alejandro Datas
64	Thank you for the talk - brilliant idea with huge potential for many energy saving and comfort improving applications. I am wondering if there is material that can be integrated to windows which still can reduce the solar heat gain without compromising natural light entering into the living space?	Duan Wu
65	For the hybrid metamaterials developed that achieve daytime cooling, how do they hold up over the long term? How sensitive is performance to dust/dirt accumulation or the regular 'wear and tear' of being outdoors? Does this impact their adoptability? (from Andrea, MIT student)	Andrea Michelle Lehn
66	Have you already applied this technology in commercial level?	Satoshi Nishimura
67	Prof R Yang. thanks for the awesome talk. Q - how do you decide what and how many materials (and corresponding thicknesses) to stack upon each other to enhance reflectivity and emissivity ?	Harsh Chandra
68	Since the evolution of creatures have been going on for millions of years, does this kind of materials exists in nature (animals/plants, etc.)?	WANG Gaoyuan

69	What about too much building cooling in winter conditions, which would require more indoor heating?	beysens
70	Are methods for regulating humidity built into the material? Please explain.	varun
71	what will be the life of such metamaterial and their carbon foot print?	Anonymous Attendee
72	Very naive question: would it be at all possible or realistic to cover cooling roofs by, say, black tarps on the onset of winter to mitigate the heating penalty?	Simon Thebaud
73	If this material radiates heat into the atmosphere, will it not increase the atmospheric temperature?	Tejas Mahajani
74	What is the IR emission efficiency from normal white paint? This will tell us the margin we can improve, right.	Shigeo Maruyama

75	Thank you for the great talk! The radiative cooling metamaterials will definitely be useful for energy saving in constantly hot areas like Texas. However, in many big cities like New York and Beijing a large fraction of the year is cold with peak temperature < 20C. In these days the household needs warming instead of cooling, and the radiative cooling roof may increase the energy consumption. Have you calculated this balance of over-the-year energy saving when using the radiative cooling materials in regions of different climate? Thanks!	唐克超
76	Thanks for such an amazing overview of the topic. Could you share some views about the radiative cooling of solar panels and how significant it could be as compared to other cooling techniques such as convective cooling by air and water.	Salman Ahmed
77	At the molecular level, how can one explain the physical understanding of the overall process?	Sidharth Raut
78	Will the humid climate have effect?	Anonymous Attendee
79	Thank you so much for your good presentation. I may have missed it, what was the thickness of the film when you measured these data? Is there a minimum required range?	Anonymous Attendee
80	Is it possible to achieve sub-ambient cooling in conventional white paint? There doesn't seem to be a fundamental limit that this cannot be done.	Anonymous Attendee
81	can this coating be used in automobiles effectively reducing fuel consumption?	Arjun Thangaraj R

82	Will the radiation cooling make the objective cooler in the winter? What can we do to reduce the heat dissipation of objective in winter?	John Peng
83	What's the radiation density (w/m2) of the material through the atmospheric window?	Paul Wang
84	Is the sky cool technology commercially available?	Anonymous Attendee
85	what about cooling at oblique angle?	Philippe Ben-Abdallah
86	Another question: the data shown are mostly measured with wind-proof setup. How much is the impact of wind in the measurement of cooling temperature?	唐克超
87	How is the dust accumulated on the meta material going to affect the cooling?	Anonymous Attendee
88	The temperature difference is NOT the key point. It's closely rated to the thermal isolation of the space. The radiation density (w/m2) of the material just through the atmospheric window is more important. What's that?	Paul Wang
89	How does the environmental impact of producing these materials compare against the production of more common insulation methods?	Nicole Tang Liwen
90	Would it be beneficial to integrate sky cool with solar thermal collector?	Xiaobing Liu

91	Most of the materials, such as concrete and glass have radiative cooling effect. I am wondering if there is any advantage of the metamaterial in comparison to these materials, such as a reflective mirror?	Anonymous Attendee
92	What are the possible solutions of cooling for high rise buildings?	qianying wu
93	can cars be coated?	Anonymous Attendee
94	(Answer) There has been work on this using conventional "cool" coatings. See Lawrence Berkeley National lab heat island group...	
95	cars are really hot in summer and accidents occur to babies. what would be the difficulty to apply this material to cars.	Anonymous Attendee
96	thanks, is it possible to make sun scream have the function of radiative cooling? What type of materials we should consider for this application?	Anonymous Attendee
97	Is it possible that the temperature drop can be greater? For example, by more than 50 ℃. What measures can be taken?	ydl
98	Not sure if out of scope, but could you comment on the possibility of actively pumping heat from earth to space? i.e. by using radiative heat pumps (e.g. LEDs) rather than passive elements like reflectors/emitters.	Alejandro Datas

99	Topic ideas-Inviting someone from government or industry to discuss the challenges they face and ideas/new programs to help place	Anonymous Attendee
100	Topic: heat pump	Paul Wang
101	Would it be possible to have a feedback about the number of asked questions?	Philippe Ben-Abdallah
102	Suggestion on topics: pool boiling	Han Hu
103	Topic: human to Mars	Anonymous Attendee
104	Phononic metamaterials	Zihao Zhang
105	I would like to hear atmospheric water harvesting for sustainable development	Bathina Chaitanya
106	Suggestion for topic - role of combustion in the future energy mix.	varun
107	I would be interested in the use of micro- and nanotechnology for waste heat recovery. Thanks.	Anonymous Attendee
108	Using machine learning in heat and mass transfer	Anonymous Attendee

109	Thanks professor Yang for your exciting speech. I can see a wide range of application of the radiative cooling materials in saving energy. I want to ask whether this kind of material is degradable or not? Can the materials be reused after its performance becomes worse?	Aileen
110	I'm really interested in personal/athletic clothing design. Imagine if it is too hot and you put on a jacket that keeps you cool rather than keeps you warm. Would something like this ever be possible?	Andrea Michelle Lehn
111	thermionic energy conversion, thermophotonic cooling, near-field thermophotovoltaics.	Alejandro Datas
112	Topic suggestion: Materials Informatics for Thermal Innovation (Shiomi)	Tengfei Luo
113	Phase change materials	Anonymous Attendee
114	Suggested future topic: Thermal challenges for heterogeneous integrate, Prof. Dereje Agonafer	Mark Spector
115	thermal technologies for desalination/water treatment	Akanksha Menon
116	long duration energy storage	Akanksha Menon
117	Topic Suggestion: Radiative characteristics of pv cells and aerogels	Umair Arshad
118	if we suggest some topic, when the lecture is given on that topic?	Anonymous Attendee