Passive Radiative Cooling Technologies for School and Company Buildings in Rwanda

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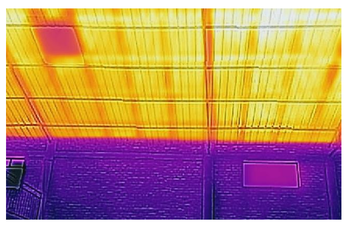
Cool White

Cooperation project between
the BGA,
Business Scout for Development
program of the BMZ
and PTB

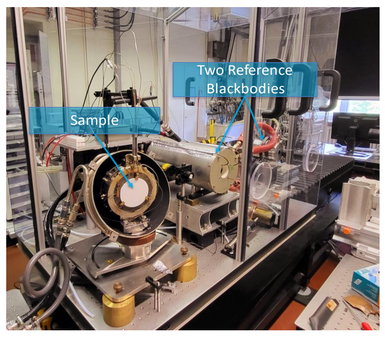


Project goal: Development and implementation of passive cooling technologies, especially the study of the cooling effect of the special white paints on the roofs of buildings and painting of school and company roofs in Rwanda and South Africa.

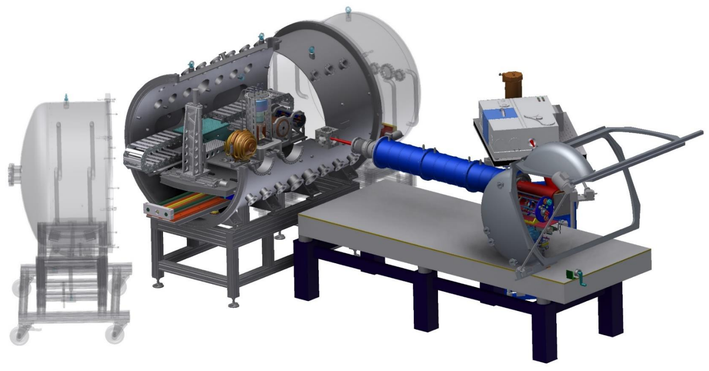
PTB: Characterization of white paints from different manufacturers and temperature measurements in the buildings.

Emissivity measurements at PTB

Setup in air: EMAF

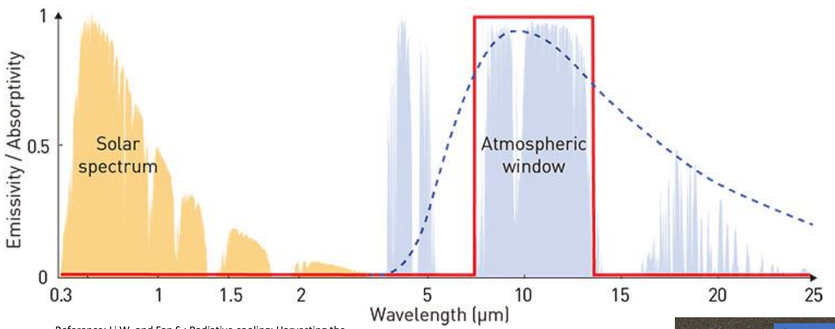


Setup under vacuum: RBCF2



	Setup in air	Setup under vacuum
Temperature range:	20 °C to 500 °C	-40 °C to 1000 °C
Spectral range:	2.5 µm to 100 µm	1.2 µm to 200 µm
Angular range:	±80°	±80°

Characterization



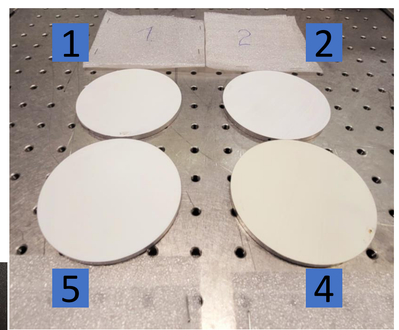
Reference: Li W. and Fan S.: Radiative cooling: Harvesting the coldness of the universe. Opt. Photonics News 30, 32–39 (2019)

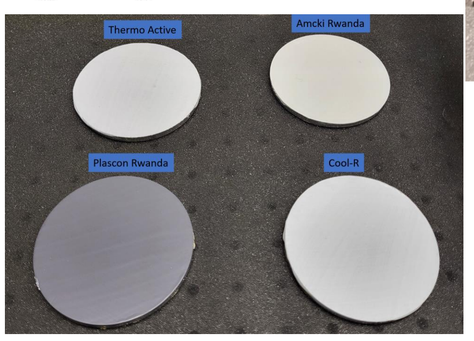
Passive radiative cooling (PRC):

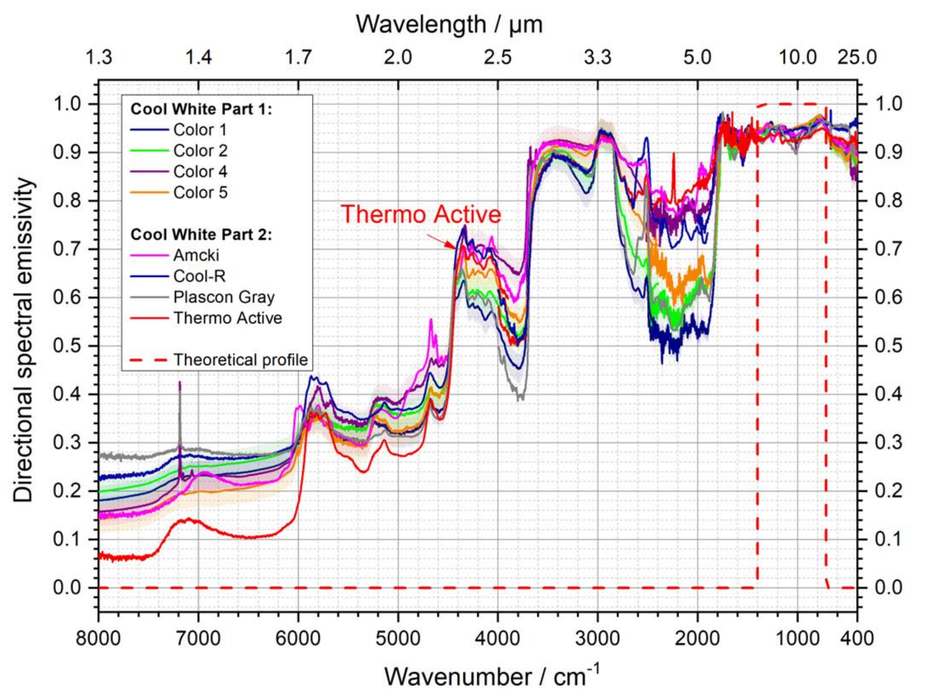
a low emissivity in the solar spectrum and a high emissivity in the infrared atmospheric window is needed to achieve cooling below ambient temperature.

Samples from Rwanda

The color samples are locally available on site.



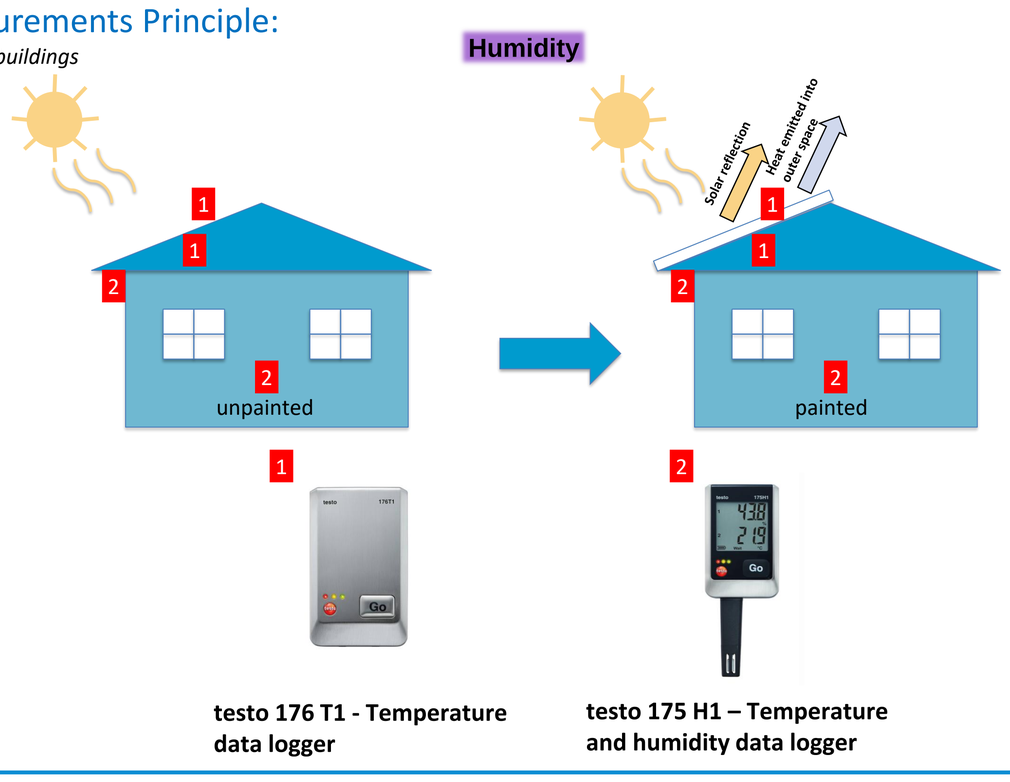




Temperature Measurements

Measurements Principle:

2 school buildings
1 factory



testo 176 T1 - Temperature data logger

testo 175 H1 – Temperature and humidity data logger

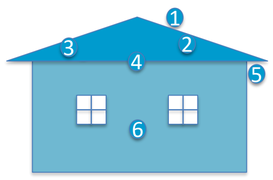
PRC materials can effectively reflect solar radiation thanks to their optical properties, but at the same time dissipate heat through the 8 µm to 13 µm infrared transparency window by using space as a cold and renewable heat sink. This makes it possible to achieve sub-ambient temperatures even in direct sunlight without the need for electricity. An accurate determination of the thermophysical properties of PRC materials, such as reflectance and emittance, is the key to optimal and correct material selection, as well as effective optimization and development of PRC technologies. These optical properties should be measured in the broad spectral range from 250 nm to 50 µm encompassing both the solar spectrum (250 nm – 2500 nm) and the infrared transparency window of the atmosphere (8 µm – 13 µm).

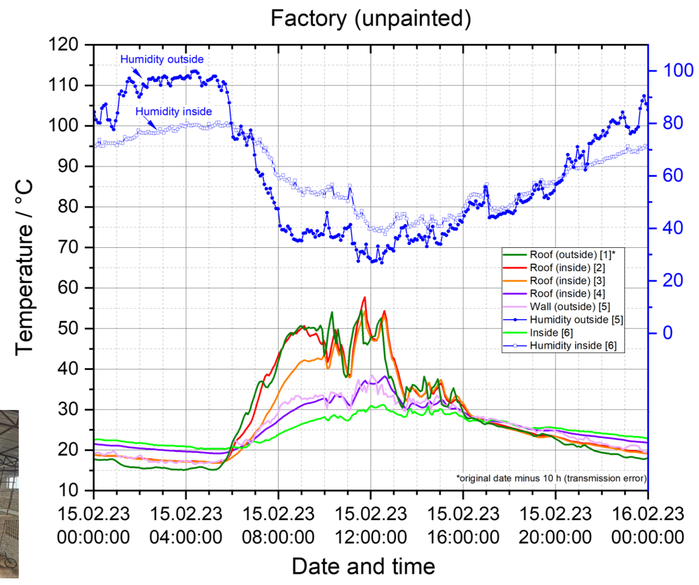
PTB brought its expertise in determining optical properties to investigate different white colors, select the best possible ones and provide training to the local Rwandan metrology institute on how to attach the temperature and humidity measurements to the roofs. As first results, we show the emissivity data of 8 different PRC coatings available on the local market and the temperature data of the unpainted and painted buildings in Rwanda.

Based on the emissivity results, the best white coatings were selected. The roofs of the school buildings were half coated to allow a direct comparison of the separate rooms within the same building. The first temperature and humidity results of the painted buildings will be available soon. The measurements of the painted buildings were recently started in South Africa on similar scheme. For future temperature measurements, we are planning the additional use of WiFi sensors (testo Saveris 2 H2) to accelerate the data readout and facilitate the work.

testo Saveris 2 H2- Temperature data logger with 2 temperature sensors (NTC)

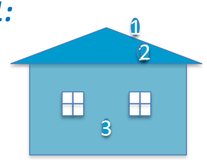
Factory-unpainted





School buildings-unpainted

Block 1:



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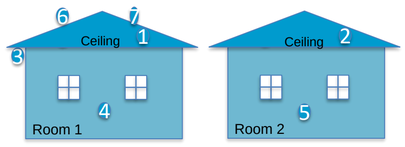

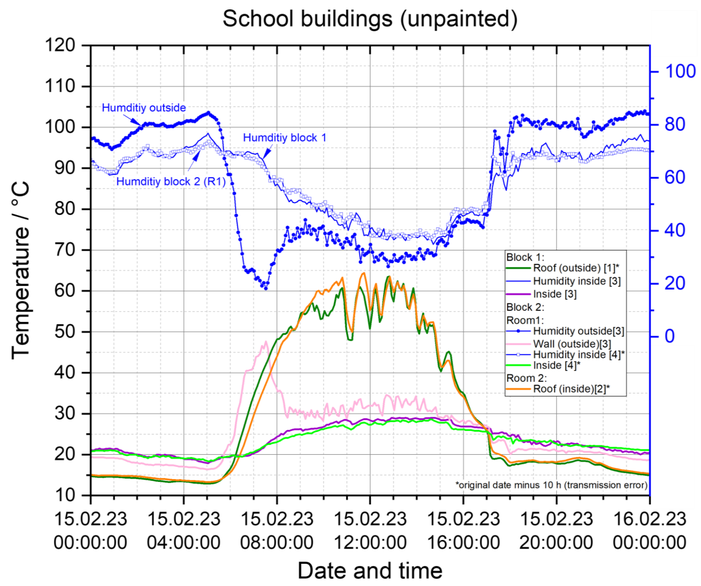

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