結合矽基氣凝膠之高效節能建材產品開發與量產計畫

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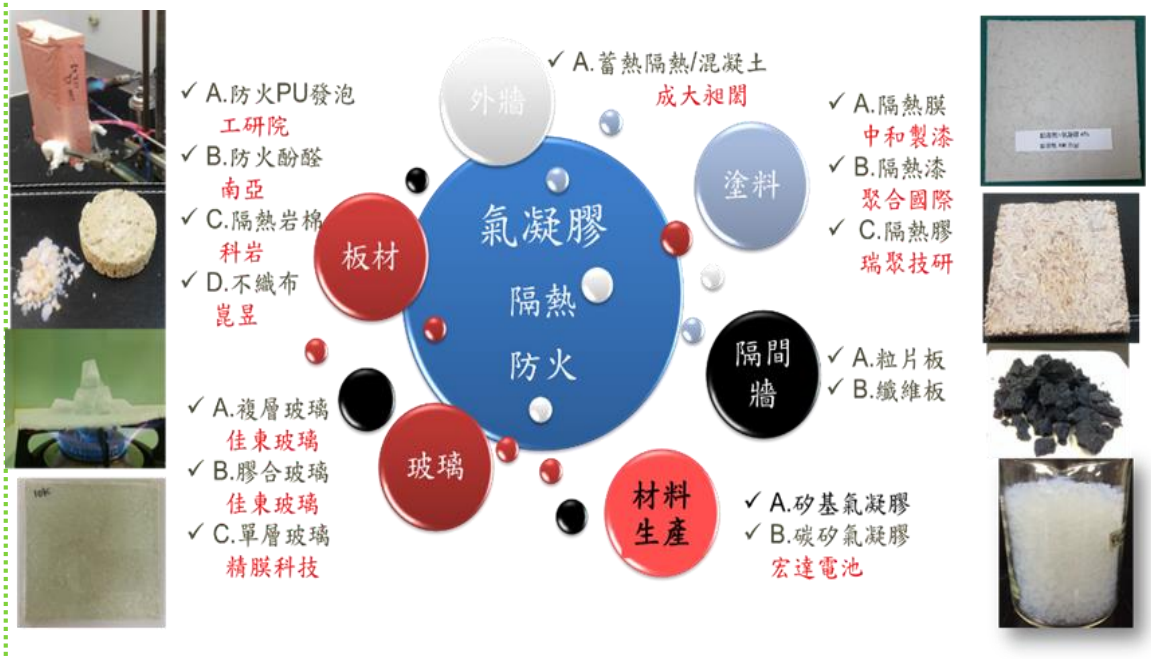
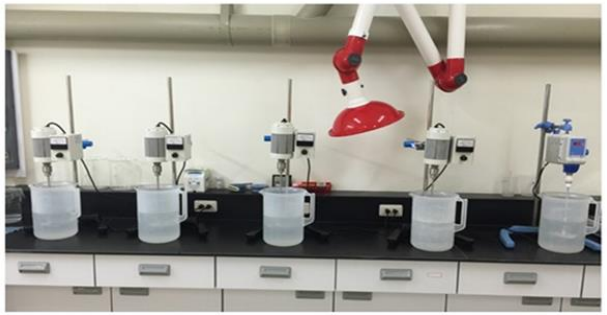
鑑於氣凝膠的低熱傳導、高透光、低折射率以及防火等優越性能，本計畫依照建築物外殼主要三大構造：屋頂、外牆與窗戶，以氣凝膠為基礎材料開發此三大構造的節能建材。並將上述開發建材納入模擬軟體與全尺寸實驗屋中，進行建築物節能效益評估，驗證本計畫所開發之節能建材確實能有效降低建築物用電量達30%以上。

申請「具有裝飾層的隔熱牆體」、「具有隔熱塗層的牆體構造」與「牆體隔熱構造」等與氣凝膠相關之國內外新型與設計專利共6個，分別為台灣4個、中國1個、美國1個。



本團隊研發出三種氣凝膠製程：氣凝膠常壓乾燥製程(10公斤級)、 次微米珍珠狀氣凝膠製程(料徑最小)、氣凝膠直接疏水化製程(成本最低)；並且建置「直接疏水化製程」每批次1公斤之實驗工廠，成本降至3000元/公斤。再者，以氣凝膠研發出防火隔熱效果優異之建材，如：結合相變化蓄熱材料並以水泥砂為介質，作為建築外殼防水節能塗層，並且以技轉給成大昶閎公司。高透光高隔熱膠合玻璃，具高透光高紅外線吸收可取代市場上low-E玻璃。子計畫主持人陳長仁教授於2016年榮獲C.B.T.I.A世界發明家大賞及第11屆台灣十大發明家殊榮。其團隊亦奪得2016台灣國際創新發明暨設計競賽 銀牌獎。另研究論文：To improve the heat insulation efficacy of mineral wool by adding aerogel，獲得2016 ICASI國際研討會最佳論文獎。



直接疏水乳化氣凝膠實驗工廠

全尺度實驗屋

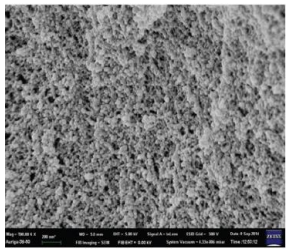
建材性能與節能效益評估檢測設備

Manufacture of high energy efficient building materials with SiO2 aerogel.

Execution Unit	National Cheng-Kung University
Project Director	H.T.Yang

Since aerogel features low-thermal conductivity, high transparency, low refractive index and fire-resistance, the project developed green building materials based on aerogel for building structure of roof, exterior wall and window. To verify that the green building materials developed does in fact reduce electricity up to 30 percent effectively, an evaluation will be conducted to assess building energy efficiency, including the materials developed above in the simulation software as well as full-size experimental house.

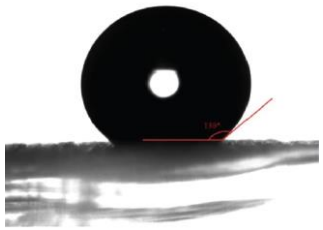
Patent applications: 4 in Taiwan, 1 in China, 1 in USA, made up a total of 6 new model and design of aerogel related patents such as "insulating wall with decorative layers", "wall structure with insulating paint", and "wall structure with insulation system".



SEM of NCKU Aerogel

Characteristics	Value
Specific surface area	800~1000m²/g
Density	148kg/m³
Particle size	44~177μm
Pore size	32～82nm
Thermal conductivity	0.038W/m.K at 25℃
Drying method	Ambient-pressure drying
Surface chemistry	Superhydrophobic
Contact Angle	138°

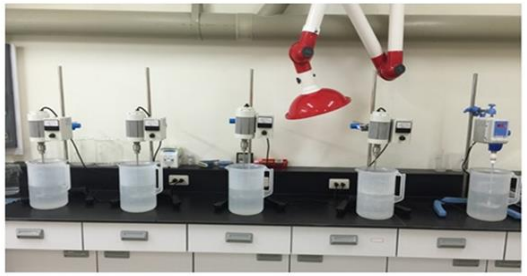
NCKU Aerogel Performance



Contact angle of NCKU Aerogel

Silicon base Aerogel powder

Three ways of aerogel production process are created: aerogel ambient pressure drying process (10 kg), submicron aerogel (smallest diameter), emulsification process (lowest cost). Experimental factory of direct hydrophobization will be established to cut down the cost to $3000/kg. Further, aerogel will be used to develop building materials with fire-resistance and heat-insulation efficacy, such as synthesizing phase change materials by introducing cement as waterproof energy efficient paint for building envelope. The technology, in the end, has been transferred to TECHOME Technology CO. Ltd.. Aerogel double-layer glass with high transparency and high IR absorption will be able to replace low-E glass in the market. The subproject investigator, Prof. Chang-Ren Chen, was awarded by C.B.T.I.A in 2016 and 11th Annual Top 10 Inventors in Taiwan. Meanwhile, the team was also honored a silver medal by Taiwan International Invention and Design Fair in 2016. The paper "To improve the heat insulation efficacy of mineral wool by adding aerogel" was chosen as the best paper in 2016 ICASI International Conference.



Experimental factory of aerogel powder

Energy-efficient building testing house

The testing equipments for building material energy-saving efficiency