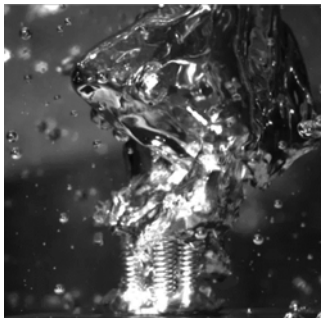
附件四、技術說明表

應用於跨重力場的氣泡移除結構



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市場及需求: 光電化學反應、電子散熱、太空衛星、沉浸式散熱

技術摘要(含成果):

本專利提出了一種利用特殊螺旋線結構的被動式氣泡移除技術。該技術透過在每個氣泡內引入恆定的壓力梯度，利用壓力不平衡，促進氣泡的上升和脫離，無需外部力或複雜的表面改質。本專利可在地表、微重力環境或不同重力場中，解決傳統的沉浸式冷卻面臨氣泡無法順利脫離加熱表面或化學反應中電極產氣而無法排除的問題。

優勢:

- 無需外部動力：純粹依靠壓力差促進氣泡脫離，降低能耗，提升系統的能源效率。
- 結構簡單，易於維護：非線性螺旋線結構設計簡單，無需複雜的表面處理或機械部件，降低了製造和維護成本。
- 在散熱系統中顯著提升冷卻性能：與自由脫離相比，線性和非線性螺旋線結構使氣泡脫離速度與加速度分別提高了近兩倍，顯著增強了臨界熱通量。
- 在光電化學反應或其他產氣反應器系統中，可將氣體有效脫離電極表面，使反應效率增高。
- 適用於微重力環境：解決了在微重力條件下氣泡難以脫離的問題。

競爭產品:

- 機械泵送系統：利用機械方式促進冷卻液循環和氣泡移除，但增加了系統的複雜性、重量和能耗，且在微重力環境下效果有限。
- 電場/磁場輔助技術：透過外加電場或磁場促進氣泡脫離，需要額外的能源供應和控制系統，增加了系統的複雜性和成本。
- 表面改質技術：對加熱表面進行親水性或疏水性改性，以影響氣泡行為。但這些方法可能涉及複雜的精密製造，不易大範圍制作，且長期穩定性可能受到限制。

專利現況:

(1)本技術已有相關專利 (中華民國發明專利: I645121, I812058)。
(2)本研究團隊具有數十年研究經驗，五年內發表 11 篇高影響期刊、累計 582 次引用的學術成就，並多次執行與中油、工研院等的產學合作，推動生質柴油和無重力兩相流等技術，獲得多項專利。研究團隊開發的 AI 石虎路殺預警系統亦被國際媒體報導並開放使用。這些經驗大幅提升專利申請的成功率和實用性

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Bubble Removal Structure for Cross-Gravity Fields

PI：Professor Ya-Yu Chiang, Department/Graduate Institute of Mechanical Engineering, National Taiwan University

Experience: https://yayuchiang.wixsite.com/mntas

Market Needs: Photoelectrochemical Reaction, Electronics cooling, space satellites, immersion cooling

Our Technology:

This patent introduces a passive bubble removal technology using a specialized helical wire structure. The technique involves creating a constant pressure gradient within each bubble, utilizing pressure imbalance to facilitate bubble ascent and detachment without external force or complex surface modification. This patent can effectively address issues in traditional immersion cooling, where bubbles struggle to detach from heated surfaces, or in electrochemical reactions where gas produced at electrodes cannot be easily removed, applicable across terrestrial, microgravity, and varying gravity environments.

Strength:

- No External Power Required: Utilizes pressure differences alone to facilitate bubble detachment, reducing energy consumption and enhancing system efficiency.
- Simple Structure, Easy Maintenance: The helical structure is simple in design, requiring no complex surface treatments or mechanical components, thus lowering manufacturing and maintenance costs.
- Enhanced Cooling Performance in Thermal Systems: Compared to free detachment, linear and nonlinear helical structures nearly double bubble detachment speed and acceleration, significantly increasing critical heat flux.
- Improved Reaction Efficiency in Photoelectrochemical and Gas-Producing Reactors: Effectively removes gas from electrode surfaces, enhancing reaction efficiency.
- Adaptable to Microgravity Environments: Solves bubble detachment challenges in microgravity.

Competing Products:

- Mechanical Pump Systems: Use mechanical methods to circulate coolant and remove bubbles but add system complexity, weight, and energy consumption, with limited effectiveness in microgravity.
- Electric/Magnetic Field-Assisted Technology: Uses additional electric or magnetic fields to promote bubble detachment, requiring extra energy sources and control systems, which increase complexity and costs.
- Surface Modification Technology: Modifies heating surfaces with hydrophilic or hydrophobic treatments to influence bubble behavior, but this often involves complex precision manufacturing, is challenging to scale, and may lack long-term stability.

Intellectual Properties:

1. The technology has related patents (ROC Invention Patents: I645121, I812058).
2. The research team has decades of research experience, with 11 high-impact journal articles published in five years, totaling 582 citations. They have collaborated with companies like CPC Corporation and ITRI on biofuel and microgravity two-phase flow technologies, securing several patents. The AI-enabled leopard cat roadkill prevention system they developed was also covered by international media and is available for open use. These experiences significantly enhance the patent's application success and practicality.

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