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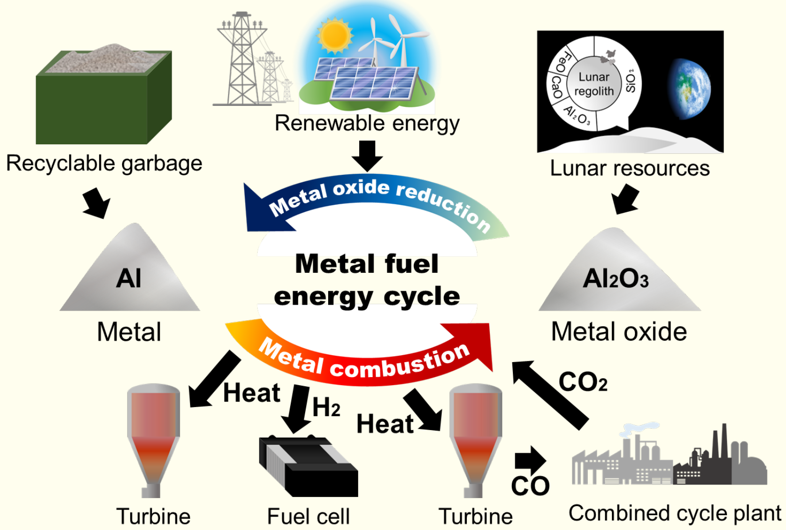
Activities of the Core

Oct. 11, 2023	Prof. Ichikawa gave an invited lecture titled “Current Status and Future Prospects of Carbon Neutrality” at the Japan Weather Association.
Oct. 12, 2023	The 84th HU-ACE Steering Committee Meeting
Oct. 14, 2023	The 5th Higashihiroshima-Ene/Eco Seminar (co-organized by HU-ACE)
Oct. 19, 2023	The 109th Biomass Evening Seminar (co-organized by HU-ACE)
Oct. 22, 2023	The Higashi Hiroshima Environmental Fair 2023 (participation)

Research on “Metal Powder Combustion Technology for Carbon Recycling” for the HIROSHIMA CARBON-CIRCULAR PROJECT Funded by Hiroshima Prefecture

A revolutionary new energy system is required to realize carbon neutrality by 2050. Research on this is being funded by the “HIROSHIMA CARBON-CIRCULAR PROJECT”, which started from October 2022. This project utilizes aluminum powder and carbon dioxide, which are attracting attention as next-generation energy carriers, as oxidants. In the project, we are conducting research to effectively utilize the heat that can be obtained by using the reaction of aluminum powder with carbon dioxide for power generation.



Related Events

The 8th International Symposium on Fuels and Energy (ISFE2024) is scheduled on July 1-2, 2024. Details will be announced later.

We have developed a roadmap for the development of energy utilization technologies leading up to 2050 and an integration scenario called the “Hiroshima Scenario”. Please feel free to share your thoughts with us.
https://hu-ace.hiroshima-u.ac.jp/wp/wp-content/uploads/2022/10/220921-brochure.pdf

Research consultation and joint research are welcome.

Issued by Advanced Core for Energetics, Hiroshima University
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Research Topics No. 45

Understanding how Plasma Window works

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Research fields: Plasma engineering
Keywords: Plasma diagnostics, turbulence, tomography, cascade arc discharge

Abstract

Background: Practical realization of the Plasma Window for quantum beam science application

Plasma window (PW) is an application of plasma that separates the atmospheric pressure and vacuum using the plasma's heat. The plasma window device produces high-density plasma inside the channel of each electrode (see Fig. 1) to add heat to the gas flowing from the atmospheric side to the vacuum region. The viscosity of the gas increases as the gas temperature increases, resulting in the choking of the gas flow through the channel. Since the PW separates the atmospheric side and vacuum region only using plasma, the PW enables us to transmit the soft X-ray and electron/ion beams to the atmospheric side. The soft X-rays and the electron beams are used for bioimaging and fine machining, respectively, though these are available only inside the vacuum. Therefore, the practical realization of the PW may pave the way for the vast application of quantum science technology.

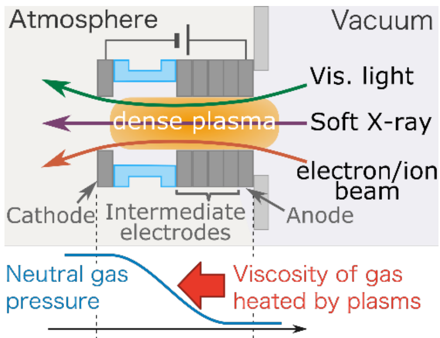

Fig. 1. Schematic view of PW.

Methods: Experimental investigation of the dependence of PW performance on channel size

Since the typical diameter of an electron beam for welding is less than 1 mm, the channel diameter of the PW, which enables electron beam welding under atmospheric pressure, is sufficient with less than 3 mm. On the other hand, the channel diameter of the PW for a large current ion beam must be as large as 8 mm. The fluid inside the conical tube is roughly classified as viscous flow or molecular flow by channel diameter and density. Although the conductance of these fluids decreases with increasing temperature, it is known that the strength of the dependence is different [1,2]. Therefore, we analyzed the dependence of the conductivity, in other words, the pressure separation capability, of PW with different channel diameters on the plasma temperature.

Results: Conductance dependence differs with diameter

The experimental results showed that the pressure separation capability of the PW with a 3 mm channel diameter was proportional to the plasma temperature [3], not the square root of the temperature. On the other hand, the pressure separation capability of the PW with an 8 mm channel diameter was found to be proportional to the square root of the plasma temperature, as shown in FIG. 2. These result indicates that the gas flowing into the channel with a 3 mm diameter can be regarded as a viscous flow. In comparison, the gas flowing into the channel with an 8 mm diameter can be regarded as molecular flow, suggesting the importance of the plasma temperature for the PW performance with a large channel diameter.

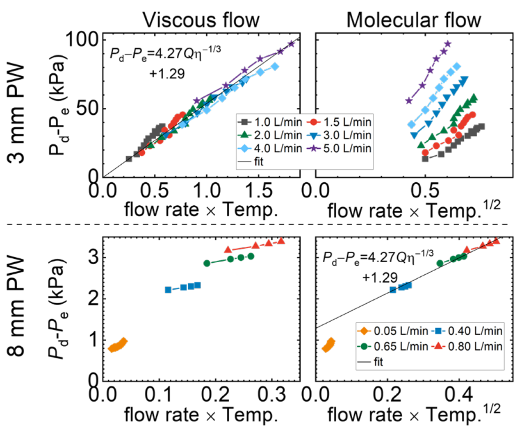

Fig. 2. Temperature dependence of pressure separation capability.

References

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2. W. Steckelmacher Vacuum **16**, 11, (1966)
3. K. Yamasaki, *et al.*, Review of Scientific Instruments **93**, 053502 (2022)