

Cryogenic cooling without helium gas

Can be used for superconducting refrigerant, cell freezing, and semiconductor cleaning

Overview

Helium is difficult to obtain and expensive, so cooling systems that use helium are expected to be difficult to continue using. The invention enables rapid cooling without helium by continuously spraying a two-phase flow of cryogenic gaseous N_2 and solid N_2 (SN_2). Specifically, it is characterized by continuously generating slush N_2 by spraying at transonic speed using a Laval nozzle.

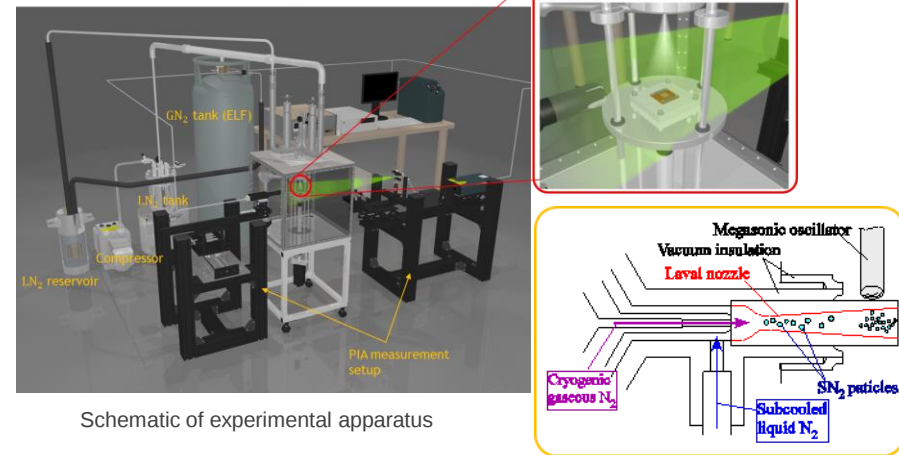
In an example of cell freezing, a 23% improvement in cell survival rate during thawing was achieved compared to liquid nitrogen immersion. This invention has the potential for application in various cooling systems beyond this specific example. Additionally, its application for resist removal in semiconductor cleaning without harmful chemicals is also under consideration.

Product Application

- ❑ Superconducting refrigerant
- ❑ Semiconductor refrigerant
- ❑ Rapid freezing of food and cells
- ❑ Semiconductor cleaning (resist removing)

IP Data

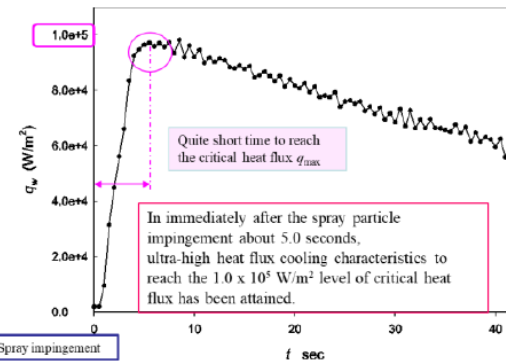
IP No. : JP4961551, JP5419000, JP6153110, JP6573363
 Inventor : ISHIMOTO Jun
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Schematic of experimental apparatus

Geometry of Laval nozzle for SN_2 particle production

Cooling characteristics by SN_2 particulate spray



Freezing rate:
Up to 25.8 (K/sec)

Irradiation time and the impact wall heat flux of solid nitrogen particulate spray

Related Works

- [1] TEION KOGAKU (J. Cryo. Soc. Jpn.) Vol.42 No.5 (2007)
- [2] TEION KOGAKU (J. Cryo. Soc. Jpn.) Vol.44 No.2 (2009)
- [3] Jun Ishimoto et al 2014 ECS J. Solid State Sci. Technol. 3 N3046 DOI 10.1149/2.009401jss

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