AN APPARATUS FOR PRODUCING MATERIAL FOAM FROM A MATERIAL AND METHODS THEREOF

IITM Technology Available for Licensing

Problem Statement

- Metallic foams can be produced from melts by introducing bubbles in the melt **either by injecting gas into the melt through a nozzle or by add-mixing a chemical blowing agent** which dissociates at high temperature and releases gas.
- **Chemical blowing agents** can result in high cost, **improper distribution of bubbles and brittleness** due to use of ceramics as foam stabilizers.
- Moreover, It **is challenging to keep the bubble size to a small size while injecting gas** into a melt. This in turn results in an increase in average bubble/cell size.
- There is a need for an efficient, economic and simple apparatus and method to produce material foams from molten metal

Intellectual Property

- IITM IDF Ref.**1562**
- **IN 534445 Patent Granted**
- **PCT Publication No: WO/2019/049175**

TRL (Technology Readiness Level)

TRL 4 Technology Validated in Lab

Technology Category/ Market

Category- Advance Material and Manufacturing
Industry Classification:

- **NIC (2008)- 28230-** Manufacture of machinery for metallurgy; **2431** Casting of iron and steel; **2432** Casting of non-ferrous metals.
- NAICS (2022)-**33351-** Metalworking Machinery Manufacturing ; **3315** Foundries
- **Applications-** Metal foams are useful in mechanical and acoustic energy absorption applications, lightweight applications, heat exchangers, CO_2 scrubbing, flame arresters, etc.

Market drivers:

The global metal foam market size is predicted to grow from USD 86.21 million in 2023 to USD 128.01 million by 2032 with a CAGR of 4.49%.

Research Lab

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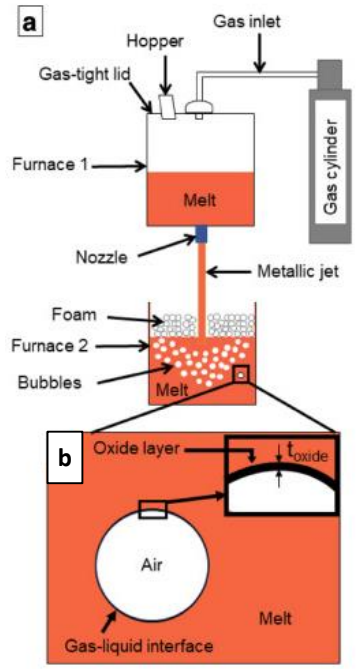

Figure: (a) Schematic of experimental setup to produce metal foams by melt injection, **(b)** schematic representation of a single bubble showing gas-liquid interface and surrounding melt. **(b)** actual photograph of melt injection setup

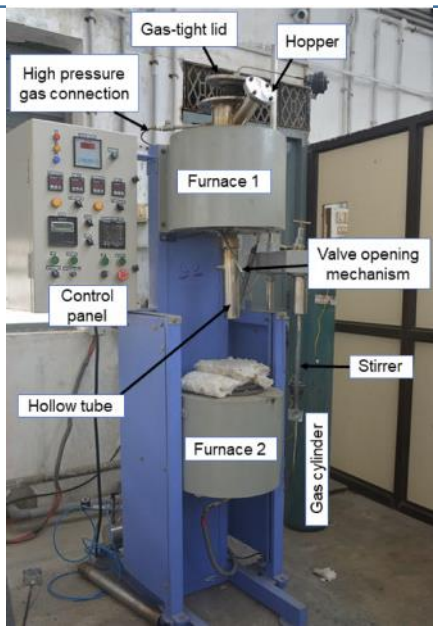

Figure: Actual photograph of melt injection setup

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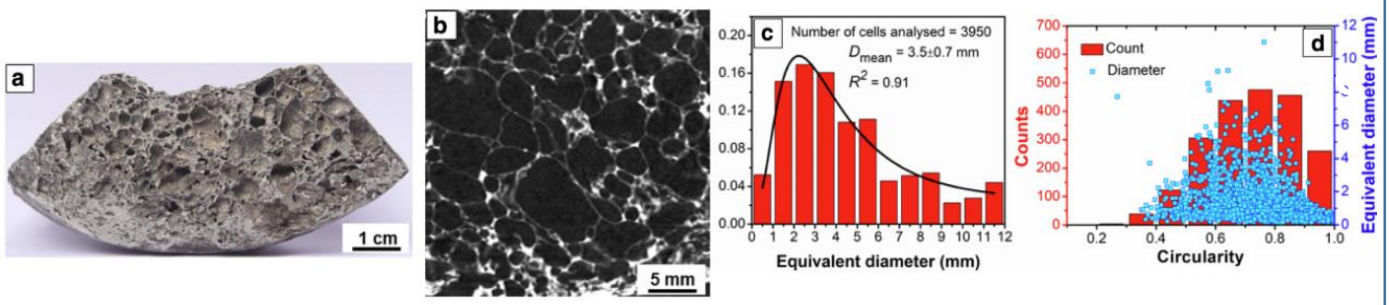

Figure: (a) Photograph of pure aluminium foam**, (b)** 2D slice of X-ray tomogram of the same foam and **(c)** corresponding cell size distribution as a function of equivalent diameter**. (d)** Counts vs. circularity and equivalent diameter vs. circularity. The solid line in **(c)** represents the fitting using a log-normal function**.**

Technology

Two high temperature crucibles capable of handling molten metal are connected to each other through a pump and nozzle. The nozzle is attached with a valve to allow the molten material to come out as a jet from the first crucible to the second

The nozzle in the first crucible is surrounded by a hollow tube which is connected with a gas inlet and outlet. The gas inlet is connected to a tube which is connected to two types of gases- an inert gas and oxygen or air.

When the nozzle is opened, a metallic jet comes out from the first crucible and impinges on the surface of the molten material kept in the second crucible. The jet entrains gas that is present in the atmosphere surrounding the jet while impinging on the surface of the molten material to create a foam on the surface of the molten metal which can be removed using a metallic scrapper

The quality of the foam can be controlled by changing the inner diameter and length of the nozzle, varying the gas pressure in the first crucible, varying the distance between the first and second crucible, finally varying the atmosphere surrounding the metallic jet.

Key Features / Value Proposition

- This apparatus can be used for producing foams from any molten material including metal such as aluminum, zinc, magnesium, and their alloys and composites. This method and apparatus can also be used to produce foam from ceramic slurries and polymer melts.
- Unlike the existing methods to produce metal foam, this process neither needs any blowing agent nor any gas injection.
- The foams produced by melt injection method are stabilized by a combined action of oxide layer and particles hence there is no need of any ceramic particles used in conventional methods for foam stabilization.
- The oxide layer thickness achieved inside the foam bubbles is higher compared to those achievable using conventional processes
- The process is cost-effective when compared to conventional processes that use chemical blowing agents.

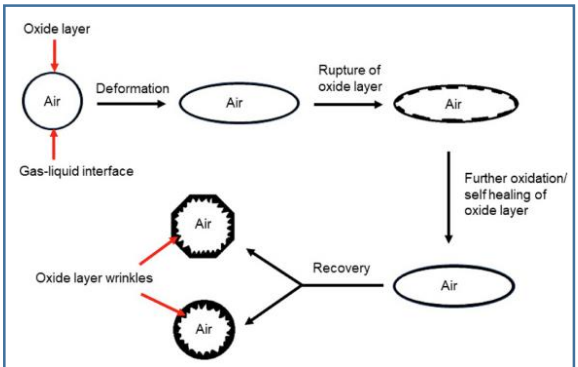

Figure: The foam is stabilized by the oxide layer. Further, The oxide layer observed in this invention is significantly thicker (1.0 ± 0.5 µm) compared to the oxide layer of other Al foams obtained from conventional processes

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