

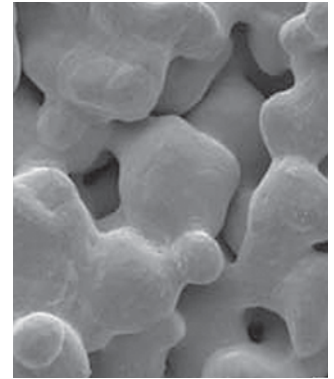
3M™ Microporous Metallic Boiling Enhancement Coating (BEC) L-20227



Introduction

3M™ Microporous Metallic Boiling Enhancement Coating (BEC) was developed to provide optimal boiling heat transfer coefficients with 3M™ Novec™ Engineered Fluids. 3M BEC is made with 3M™ Developmental Material L-20227, a powder composed of modified copper particles which are applied to a copper substrate and fused at elevated temperature. When properly applied, the BEC provides:

- High thermal conductivity ligaments at contact points between particles
- Optimally-sized nucleation sites for Novec fluids
- Performance properties that are relatively insensitive to processing conditions

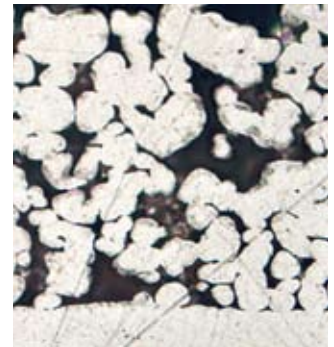
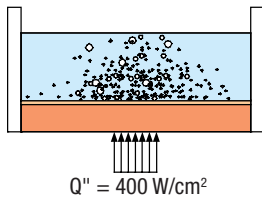
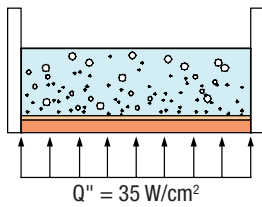


Scanning Electron Micrograph of 3M BEC.

Performance

Under uniform heat flux conditions, a horizontal BEC surface produces boiling heat transfer coefficients exceeding $10 \text{ W/cm}^2\text{-K}$ when boiling 3M™ Novec™ 7000 Engineered Fluid at atmospheric pressure. The dryout or critical heat flux (CHF) is typically 35 W/cm^2 but will be reduced if the surface is oriented vertically. Addition of chopped copper fibers on top of the coating before fusing will extend the CHF in both orientations.

Heat sources producing much higher heat fluxes can be cooled by applying the BEC to a copper heat spreader or “boiler” that receives the heat flux. The optimal boiler thickness and area depends upon the particular application. Effective heat transfer coefficients over $15 \text{ W/cm}^2\text{-K}$ have been demonstrated at over 400 W/cm^2 .



Cross section of 100 micron thick 3M BEC.

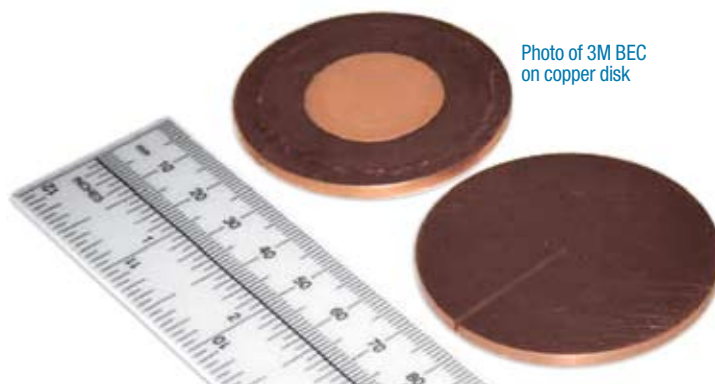
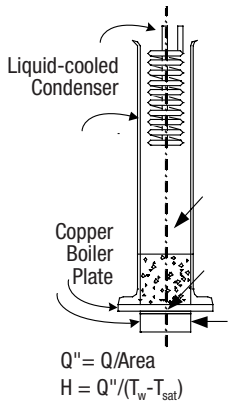
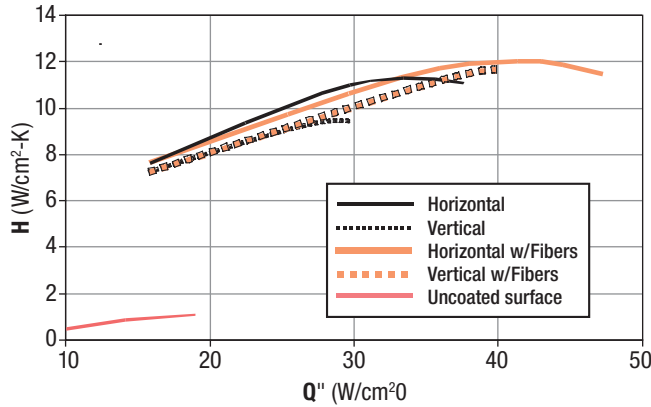


Photo of 3M BEC on copper disk



Measurement of boiling heat transfer coefficients for horizontal orientation.



Typical boiling heat transfer coefficients for 5cm² BEC surface with 3M™ Novec™ 7000 Engineered Fluid at P_{atm}. Addition of copper fibers at increases dryout heat flux in both orientations.

Additional Information

For application support, call 800-833-5045.

Sources for Coated Components

SPI, Inc. is the global licensee of BEC made with 3M L-20227 powder. Contact: SPI (Edmonton Alberta, Canada), Maurice Hilarius, 780-456-9771 or SPI (Manila, Philippines) Wilbert Yuque, +632 4132656

Further Reading

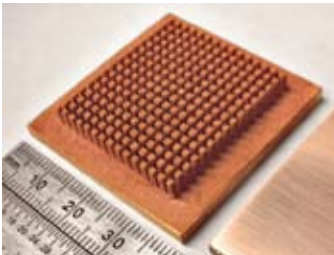
Tuma, P.E., "Evaporator/Boiler Design for Thermosyphons Utilizing Segregated Hydrofluoroether Working Fluids" Proc. 22nd IEEE SEMI-THERM Symposium, Dallas, TX, March 14-16, 2006, pp. 69-77.

Barnes, C.M. and Tuma, P.E., "Immersion Cooling of Power Electronics in Segregated Hydrofluoroether Liquids" Proc. 2008 ASME Summer Heat Transfer Conference, August 10-14, 2008, Jacksonville, Florida, USA.

Applications

3M™ BEC L-20227 can be applied to make boilers in a variety of 2-phase heat transfer systems:

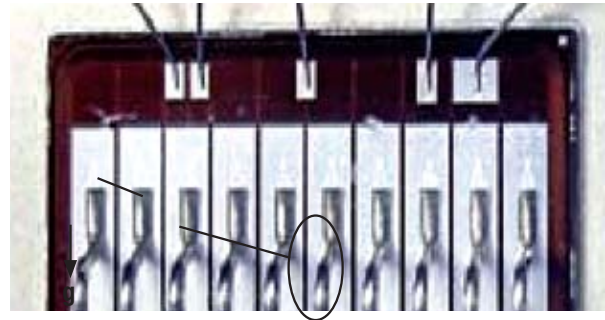
- Indirect thermosyphons can be used to cool microprocessors, LEDs, power electronics and thermoelectric devices.
- Single and dual sided immersion cooling can accommodate the rising heat densities of power semiconductors like MOSFETs and IGBTs.



L-20227 coating can be applied to complex 3-D surfaces. No pressure is needed during fusing.



Thermosyphons utilizing L-20227 coating perform better than solid copper and heat pipe based heat sinks.



Power semiconductors can be mounted to single boilers or between dual boilers coated with L-20227 coating and cooled by immersion.

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Issued: 1/09. 6645HB
60-5002-0360-3

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