Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

NOVEL HEAT SPREADERS

Copper-Diamond Composite Heat Spreaders using Cold Spray

Background

Heat spreaders are crucial components that absorb heat from miniature semiconductor dies and spread it to larger areas to facilitate effective heat removal. Cooling relies on an efficient transfer of heat from the component or device. Important properties of any heat spreader material or structure are the thermal conductivity (TC) and coefficient of thermal expansion (CTE).

Due to the large CTE mismatch between the heat spreader material and the semiconductor die, a thick layer of thermal grease (TIM1) must be applied between the semiconductor and the heat spreader to absorb the shear caused by differential thermal expansion.

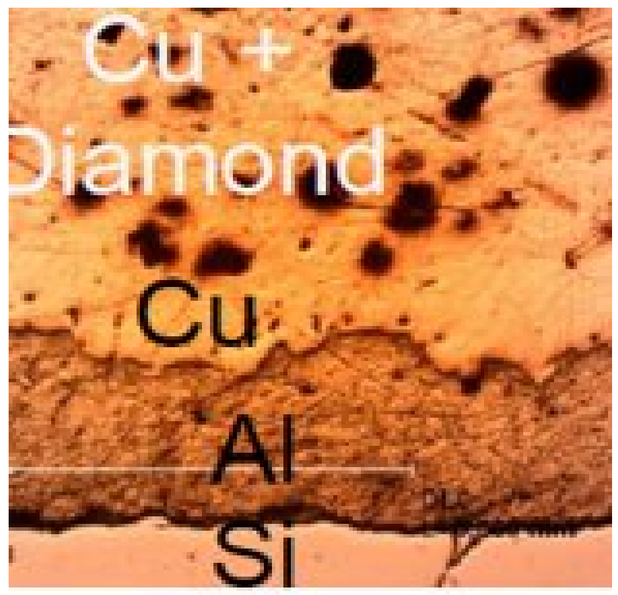
This TIM1 layer results in a significant additional thermal resistance and itself can suffer from long term reliability issues due to the operational cycles and CTE mismatching causing ‘pump-out’ of the grease

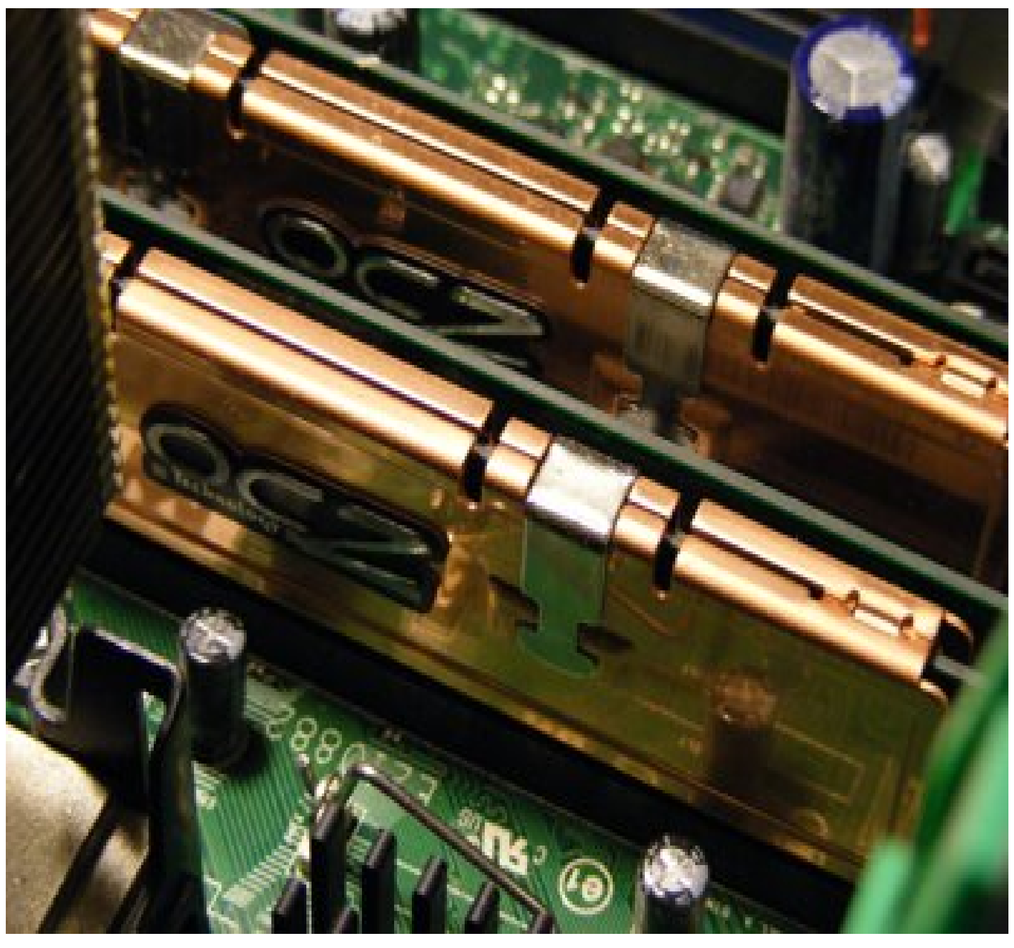
Technology Overview

- Thermal structures on semiconductors that exhibit a combination of high TC and low CTE.
- Cold Spray (additive manufacturing) allows for production of high performance heat spreaders with:
  - Tailored characteristics
  - Different materials or combination of materials such as composites or metal-composites
- Cu-Diamond matrix technology demonstrators have been fabricated with TC~600W/(mK)

Advantages

- Copper-diamond matrixes formed by cold spraying are highly thermally conductive and have a low CTE, making them extremely suitable for thermal applications such as in heat spreaders.
- Very low (potentially zero) thermal resistance at the interface between materials - and that has a 2D boiling surface on the uttermost layer.
- Removes the need for TIM1. Can be deposited directly on substrate.
- All of the above, in one single processing step





Applications

Electronics, cooling, consumer electronics, data centre cooling

Opportunity

Available to licence

Research collaboration

Publications

R.J. MacNamara, T.L. Lupton, R. Lupoi, A.J. Robinson, Enhanced Nucleate Pool Boiling on Copper-Diamond Textured Surfaces**, *Applied Thermal Engineering*, 162, 2019, p114145** Journal Article, 2019 DOI

R. Lupoi, T. Lupton, R. Jenkins, A.J. Robinson, G.E. O'Donnell, Direct manufacturing of diamond composite coatings onto silicon wafers and heat transfer performance, ***CIRP Annals - Manufacturing Technology*, 67, (1), 2018, p185 - 188** Journal Article, 2018 DOI

Technology Sector
Electronics, Novel Materials

Patent Details
Granted in US and EPO
Pending in China and South Korea

WO2019043269A1

Researcher(s)
Prof. Tony Robinson
Prof. Rocco Lupoi

Contact
Graham McMullin
Case Manager, Physical Sciences
Graham.mcmullin@tcd.ie
+353 1 896 1711

Reference:
TR02-617-01

sfi science foundation ireland fondúireacht eolaíochta éireann
Ireland's EU Structural Funds Programmes 2007 - 2013
Co-funded by the Irish Government and the European Union
EUROPEAN REGIONAL DEVELOPMENT FUND