スポット低温鍛接による異材接合技術

Dissimilar Material Joining by Cold Spot Forge Welding

低温・鍛接固相接合によるIMC抑制技術

IMC Suppression by Low-Temperature Solid-State Forge Joining

1.従来技術の課題 Issues with Conventional Technology

接合品質のばらつき
Variation in Joint Quality

反応層の形成状態が変動し、接合強度が安定しない
Variations in reaction layer formation result in unstable joint strength.

IMC形成による特性変化
Property Changes Caused by IMC Formation

IMCや反応層の成長により接合特性が変化
Growth of IMC and reaction layers alters joint properties.

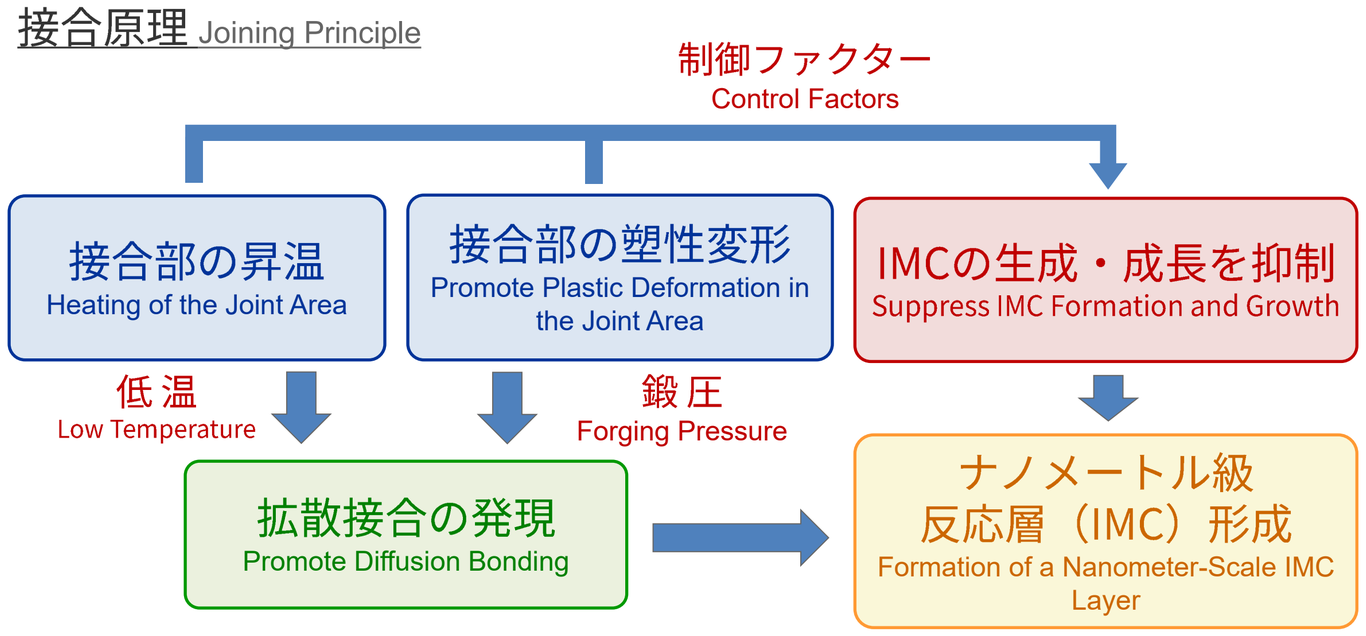
高温接合による熱影響
Thermal Effects of High-Temperature Joining

高温条件により母材や界面への熱影響が大きい
High joining temperatures increase thermal impact on the base materials and joining interface.

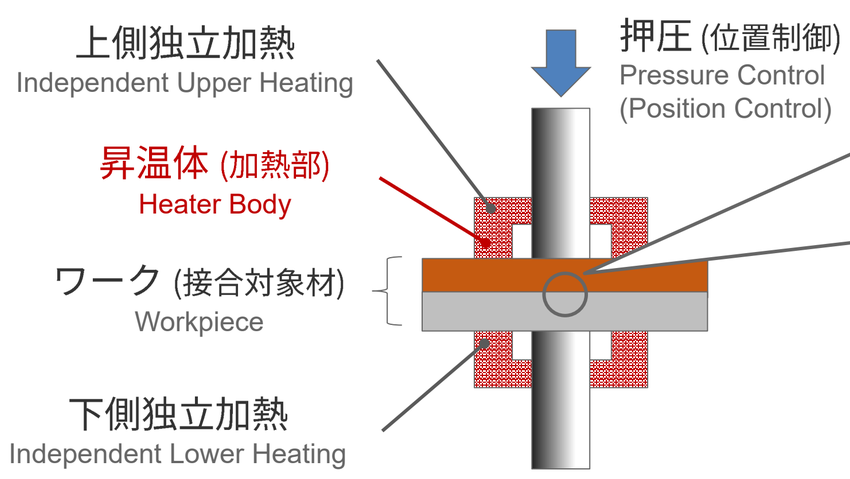
2. 接合原理・装置概要 Joining Principle and System Overview

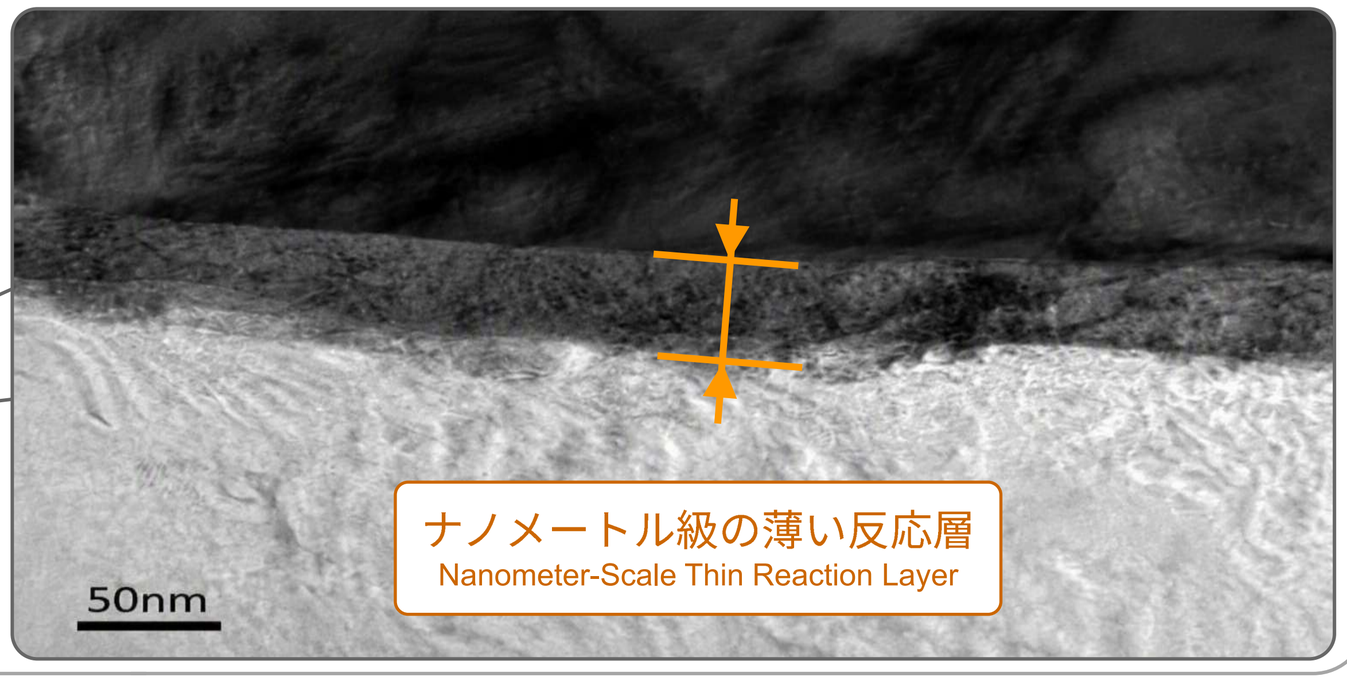
上下独立加熱と押圧制御により、低温下で拡散接合現象を発言させ、IMC生成を抑制した接合を実現します。
Independent upper and lower heating control, combined with pressure control, induces diffusion bonding under low-temperature conditions, enabling joining with suppressed IMC formation.

接合原理 Joining Principle



装置概要 Schematic of Joining Mechanism





3. 本技術の特長 Joining Principle and System Overview

低温鍛接接合
Solid-State Forge Joining

低温での固相接合を実現
Solid-State Joining at Low Temperature

IMC生成・成長抑制
Suppression of IMC Formation and Growth

IMC層をナノメートルレベルに制御
Controls IMC Layer Thickness at the Nanometer Scale

高強度接合
High-Strength Joining

異材の高強度・高信頼性接合を実現
High-Strength, Reliable Joining of Dissimilar Materials

4. 想定用途 Potential Applications

- EV・車載部品
  EV / Automotive Components
- 電池・パワーモジュール
  Batteries & Power Modules
- 異材接合部材
  Dissimilar Material Joining

5. 共同研究・特許 Collaboration & Patents

- 共同研究 Collaborative Research

富山県産業技術研究開発センター
Toyama Industrial Technology Research and Development Center

- 特許番号 Patent Information

Patent No. 7648065

スポット低温鍛接による異材接合技術

Dissimilar Material Joining by Cold Spot Forge Welding

研究成果 Research Results

スポット低温鍛接法により、ナノメートルレベルの反応層（IMC）を形成し、高強度な異材接合を実現

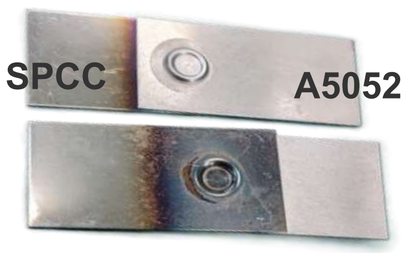
High-strength dissimilar material joining achieved through the formation of a nanometer-scale reaction layer (IMC) by cold spot forge welding.

成果1 / Achievement 1

アルミニウムと鉄の接合（Al-SPCC）
Aluminum-to-SPCC Steel Joining (Al-SPCC)

車体・構造材分野 | Vehicle Body & Structural Materials
Fe/Alパネル材接合 | Fe/Al Panel Joining

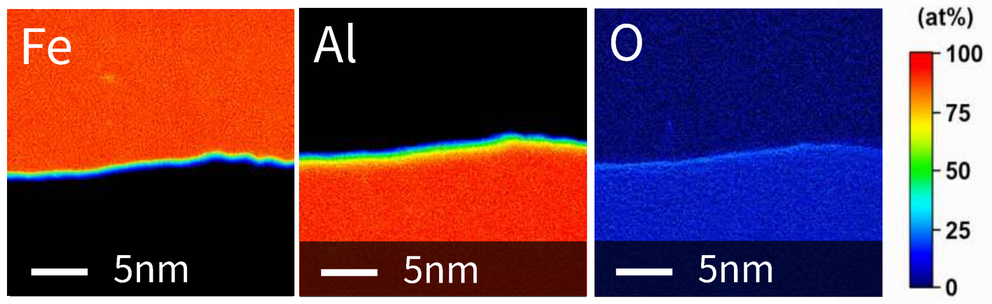
接合外観 Joint Appearance



（試験片厚さ：各 0.8 mm）
(Thickness: 0.8 mm each)

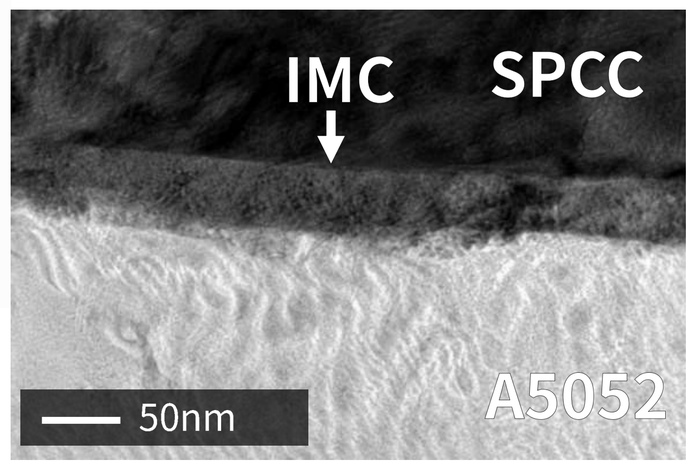
引張せん断強度
Tensile shear strength
1.3 kN

EPMA面分析 EPMA mapping analysis



- 抑制されたIMC（Fe–Al系化合物）を生成
  Fe-Al IMC formation was successfully suppressed
- 反応層（IMC）厚さ：約50 nm
  IMC layer thickness: ~50 nm

TEM観察像 TEM BF image

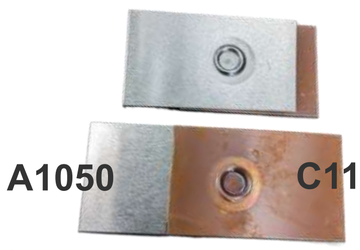


成果2 / Achievement 2

アルミニウムと銅の接合（Al-Cu）
Aluminum-to-Copper Joining (Al-Cu)

電機分野 | Electrical Equipment
Cu/Alバスバー接合 | Cu/Al Busbar Joining

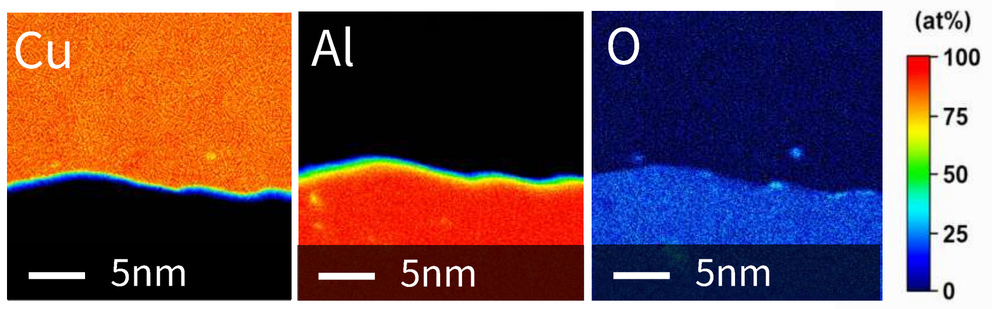
接合外観 Joint Appearance



（試験片厚さ：各 0.8 mm）
(Thickness: 0.8 mm each)

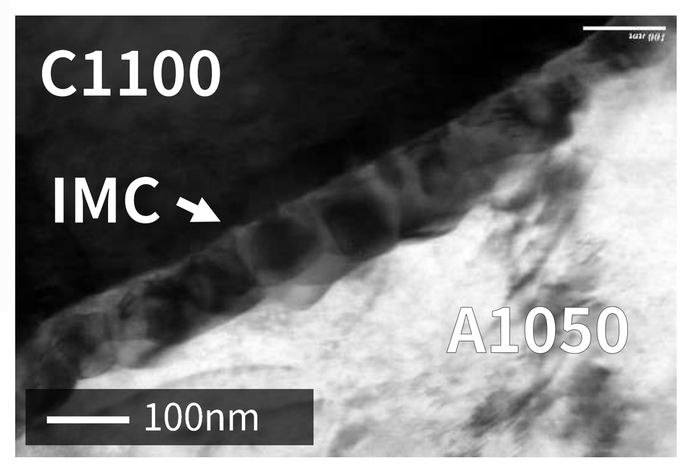
引張せん断強度
Tensile shear strength
0.7 kN

EPMA面分析 EPMA mapping analysis



- 抑制されたIMC（Cu–Al系化合物）を生成
  Cu-Al IMC formation was successfully suppressed
- 反応層（IMC）厚さ：約100 nm
  IMC layer thickness: ~100 nm

TEM観察像 TEM BF image

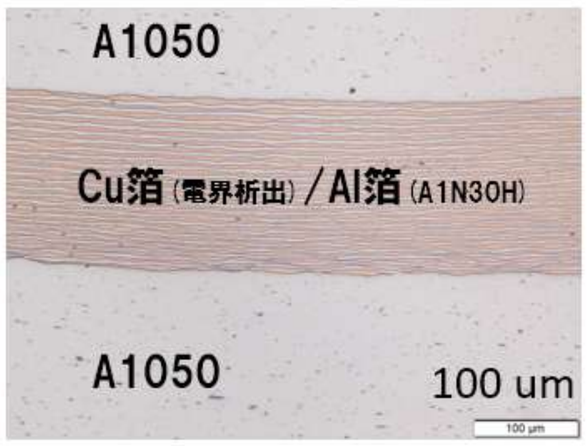


成果3 / Achievement 3

銅箔とアルミ箔の接合（Cu箔-Al箔）
Copper Foil-to-Aluminum Foil Joining (Cu Foil–Al Foil)

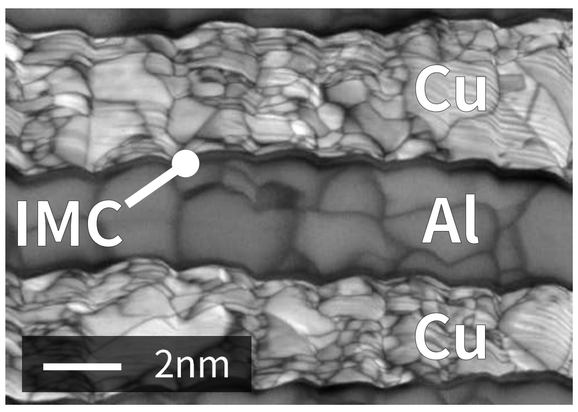
電機分野 | Battery Applications
LIB直列接続 | Lithium-Ion Battery Serial Connections

断面マクロ像 Joint Appearance

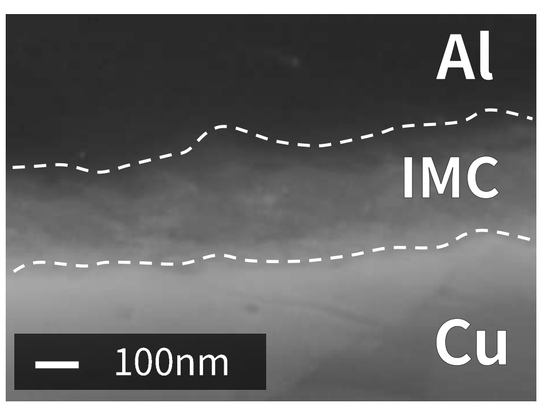


Cu箔： CF-LB9-15　t 15 µm × 25
Al箔： A1N30H　t 15 µm × 25
Al板：A1050　t 0.8 mm

EBSD IQ map Joint Appearance



TEM観察像 TEM BF image



- 全層にわたり抑制されたナノメートル級反応層（IMC）を確認
  Nanometer-scale IMC layer observed
- 電池性能向上の可能性
  Potential for battery applications demonstrated