

Forging Ceramics: Bioinspired Oxides with Metal-like Toughness

This invention addresses the long-standing brittleness and limited formability of ceramics by introducing a nacre-inspired oxide material that combines toughness, high-temperature plasticity, and design flexibility. Unlocking applications previously dominated by metals and polymers.

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Intellectual property information
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Proposed Uses

This technology addresses three major markets where ceramics have long been desired but limited by brittleness and manufacturability. In consumer electronics, it enables curved, scratch-resistant casings for smartphones, laptops, and tablets that are currently made of weaker materials such as Gorilla Glass or aluminium. In defence and security, it allows the development of body and vehicle armour with curved and more complex shape, increasing the comfort and area protected while being partially based on materials already used for these application. In aerospace, it provides lightweight, oxidation-resistant components capable of withstanding extreme heat and corrosive environments, thereby extending performance beyond what metals and polymers can achieve.

Beyond these primary markets, luxury goods (premium watches and accessories) can benefit from its scratch-proof finish and durability, while industrial manufacturing can exploit its forgeability to create complex parts for high-temperature and corrosive processes.

Problem addressed

Ceramics offer high strength, stiffness, hardness, and resistance to heat and corrosion, but their brittleness makes them prone to catastrophic fracture. This restricts use in safety-critical areas such as aerospace, armour, and electronic casings. In addition, their inability to be formed into complex geometries limits design and manufacturing flexibility.

Current approaches provide only partial solutions. Polymer- or metal-toughened ceramics lose stability at high temperature. Fully ceramic composites achieve strengths of 200–500 MPa but remain limited to <2% plastic strain, offering little practical formability. These constraints mean existing materials cannot simultaneously deliver toughness, shape complexity, and durability under extreme conditions. A new ceramic is needed that overcomes brittleness while preserving intrinsic ceramic advantages.

Technology Overview

This invention introduces a nacre-inspired oxide ceramic with a brick-and-mortar microstructure that combines toughness, high-temperature plasticity, and oxidation resistance. At room temperature, it matches the strongest ceramic-ceramic composites (200–500 MPa strength) while providing some damage tolerance. Above 1000 °C, it achieves >20% strain in bending, a level of plasticity previously only seen in metals.

Unlike conventional ceramics that are brittle and fixed once processed, this material can be forged into curved and complex geometries and even re-forged to extend its lifecycle. Compared with polymer- or metal-toughened systems, it maintains strength and toughness without sacrificing high-temperature stability. The process is inherently scalable and compatible with standard ceramic processing equipment, creating a differentiated pathway for reliable, formable, and sustainable ceramics in advanced applications.

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Benefits

- High-temperature plasticity: >20% strain at >1000 °C (vs <2% in ceramic composites)
- Allows curved and complex geometries
- Increase comfort and area protection
- Fully oxide, provides complete oxidation resistance at high temperature
- Strength 200–500 MPa at room temperature
- Tougher than monolithic ceramics at room temperature
- Enables forging and re-forging at steel forging temperature
- Extends lifecycle and reduces waste
- Compatible with standard ceramic processing equipment