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Metallic Films with Precisely Engineered Multimodal Architectures

Background

Increased material strength and ductility are almost universally desired. However, a well-known tradeoff between the two parameters exists: Strong materials (such as ceramics) are typically brittle, while ductile materials (such as metals and metallic alloys) generally exhibit low to moderate strength. Efforts to overcome this strength-ductility tradeoff have fueled research into synthesis of materials with multimodal microstructure (MM).

In MM materials, two or more grain families (ranging in size from tens of nanometers to several micrometers) are integrated to achieve enhanced strength and ductility not achievable with only a single grain size. Despite the success of MM materials in delivering optimized combinations of strength and ductility, little to no systematic experimentation has been done to analyze how the size, volume fraction, spatial distribution and connectivity of each grain family affect overall material properties. A method able to quantify these factors would therefore be critical for designing new and effective MM materials.

Invention Description

Researchers at Arizona State University have developed a new process for synthesizing metallic/metallic-alloy films with precisely controlled multimodal microstructures. Two or more distinct grain families varying greatly in size and orientation are introduced by exploiting different film growth modes. Mean size, volume fraction, spatial distribution and connectivity of individual grain families are explicitly controlled, allowing precise understanding of their relationship to the resultant mechanical properties (e.g., strength, ductility, and mechanical energy dissipation).

Potential Applications

- Microelectromechanical systems (MEMS)
- Structural material coating
- Damping of micro/nanoscale systems

Benefits and Advantages

- Systematic – Allows microstructural parameters to be precisely defined for optimization of mechanical properties
- Unprecedented – Provides an unmatched level of control for MM film synthesis
- Practical – Offers a scalable solution to design and test novel MM film applications and extract valuable data from each iteration

Homepage of Professor Jagannathan Rajagopalan