【Grant - in - Aid for Scientific Research on Innovative Areas(Research in a proposed research area)】
Science and Engineering

Title of project : Materials Science on mille-feuille structure
– Development of next-generation structural materials guided by a new strengthen principle –

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【Purpose of the Research Project】

In order to solve the energy problem and realize a sustainable society, one of the prominent issues in materials science is to develop high-strength, light-weight structural materials. In our research project, we establish the "Kink strengthening phenomenon" as a univerasal strengthen principle, which has been firstly discovered in the LPSO-structured Mg alloy that revealed unusual high-strength beyond theoretical predictions. The LPSO structure can be generally viewed as "Mille-feuille structure", in the sense that they are constructed by alternate stacking of microscopic hard- and soft-layer. Establishing a universal kink principle applicable to any mille-feuille structures will lead to a new academic, innovative area. Furthermore, based on the established "kink stengthening principle", we will be able to design new alloys including Ti and Al alloys and further new polymer materials, providing an exciting opportunity for the development of next generation structural materials.

【Content of the Research Project】

Since kink formation and stengthening are not fully understood yet along with the existing solid deformation theory, it is indispensable to provide cross-disciplinary opportunities beyond the conventional frameworks, in order to establsih a new academic field "Materials Science of a Mille-feuille structure". In our research project, researchers participate across the wide reserach fields that are indispensable for the present tasks, the majour three of which are "Materials synthesis (monozukuri)" "Solving the kink mechanism (elucidation of fundamental properties)" "Theory construction (universal principle/concept)". We will be all together to form "Japan National Team" to tackle these challenging issues, creating a new universal academic field.

There are four research groups in our project. In **A01 group**, along the experiences with the LPSO-type Mg alloys, we will attempt to develope novel Mg alloys having various mill feuille structures. In **A02 group**, we will try to elucidate the kink mechanism by performing mechanical experiments, advances structural measurements and computation modeling. In **A03 group**, a kink strengthening theory will be constructed under the effective collaborations between multiple fields including materials science, mechanics, physics and mathematics. In **A04 group**, we will try to develop and synthesize novel metal- and polymer-base Mille-feuille materials according to a proposd kink strengthening theory.

【Expected Research Achievements and Scientific Significance】

❶ Establishing a novel strengthening principle of the Millefeil structure makes it possible to develop higher strength structural materials including new Mg, Ti and Al alloys, and further polymer based materials, contributing to an esablsihement of a ebergy-saving, sustanable society.

❷ Establishment of the systematic kink strengthening theory of the Millefeil structure is engraved in history as a new material strengthening method, and hence leads to worldwide reputation in a material science field.

❸ Elucidation of the kink strengthening mechanism, based on the hierarchical structure science from the atomic level to the mesoscopic structures, brings out a drastic extension into a new solid mechanics that includes novel geomotry and non-linear elastic theory.

❹ Establishment of a new academic field "Materials Science of a Mille-feuille Structure" brings a great influence on wide basic-reserach fields, as well as an effective growth of the engineering fields and the relevant industry.

【Key Words】

Mille-feuille Structure: A microscopic layered structure constructed by an alternate stack of hard-layer (strongly-bonded) and soft-layer (weakley-bonded). It is named after "Mille-feuille cake", which is composed of a pie layer (hard layer) and a cream layer (soft layer).

【Term of Project】

FY2018-2022

【Budget Allocation】

1,179,000 Thousand Yen

【Homepage Address and Other Contact Information】

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