Preface

Materials' functionality primarily originates from imperfections in regularities, such as defects in crystals, the research of which is now shifting to defect complexes from point defects with the aim of further improving functionality, such as dielectrics with colossal permittivity. This concept can be sloganized as "disorder in order", and the converse is also true. For example, it has recently become clear that the orders of the network structures in glass materials are related to their functionality, for example, mechanical and optical properties. This structural feature is represented by the phrase "order within disorder". "Disorder in order" and "order within disorder" are regarded as interphases between perfectly regular and random structures, which is the key factor for the evolution of materials science to a new stage. We call them "hyper-ordered structures". For this subject, the national project of "Hyper-Ordered Structures Science (Grant-in-Aid for Transformative Research Areas (A))" has proceeded to support this subject.

Hyper-ordered structures exist in a wide range of material groups, such as dielectrics, functional glasses, zeolites, superconductors, and biomaterials, and can be regarded as a treasure trove of material functionality. Attempts are underway to utilize "hyper-ordered structures" to create novel materials. Currently, details of "hyper-ordered structures" can be unveiled using sophisticated quantum beam technologies. In the theoretical approach, large-scale first-principles calculations can elucidate the functionality of hyper-ordered structures. Persistent homology can extract topological features in glassy materials. This Special Topics includes 13 invited articles related to "hyper-ordered structures" that are sufficiently interesting to appeal to the readers of JPSJ. We hope that the Special Topics will greatly contribute to the worldwide development of condensed matter physics.

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