High-pressure synthesis of novel nitrides for semiconductor, 2D devices and hard-materials

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**Background**
- Necessity of new hard materials with popularization of new structural materials such as CFRP
- Prediction of the presence of novel nitride semiconductors that can be synthesized under high pressure
- Necessity of development of new two-dimensional layered material.

**Aim**
- Development of novel super hard-materials using high-pressure metathesis reaction.
- Synthesis of high-quality nitride semiconductors which is expected for next generation devices under high-pressure.
- Growth of single crystal of two-dimensional materials via the high-pressure process.

**Development of next generation nitride semiconductors**

- **ZnSnN₂**: Nitride semiconductor
  - Bandgap: tunable (1-2 eV)
  - Trivalent cation site in GaN is displaced with Zn and Sn alternatively.
  - High-quality crystal could be obtained by proceeding the above chemical reaction under high-pressure.
  - The synthesis condition of ZnSnN₂ crystal is not so severe, showing the possibility of mass production.

**Development of 2D materials**
- Next generation materials for electronics such as Graphene and MoS₂.
- High-pressure techniques are applied for the synthesis of new 2D materials ⇒ synthesis of ReN₂.

**Development of superhard materials**
- With popularization of difficult-to-cut materials such as CFRP, new superhard materials are required.
- Investigation of change in the recovered products according to the synthesis conditions.

**Publications**

**Applied area and future prospects**
- Evaluation of pn junction characteristics of ZnSnN₂ semiconductor.
- Exploring of new two-dimensional transition metal nitride crystals.
- Cutting test for application as hard material.

**Issues for technology transfer**
- Improvement of reproducibility of electrical properties of ZnSnN₂ semiconductors.
- Theoretical interpretation of synthesis conditions for transition metal nitride.
- Searching of optimum sintering conditions for nitride-hard-materials.