

## Stability of mechanically exfoliated layered monochalcogenides under ambient conditions

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### Streszczenie

Monochalcogenides of groups III (GaS, GaSe) and VI (GeS, GeSe, SnS, and SnSe) are materials with interesting thickness-dependent characteristics, which have been applied in many areas. However, the stability of layered monochalcogenides (LMs) is a real problem in semiconductor devices that contain these materials; therefore, it is an important issue that needs to be explored. This article presents a comprehensive study of the degradation mechanism in mechanically exfoliated monochalcogenides in ambient conditions using Raman and photoluminescence spectroscopy supported by structural methods. A higher stability (up to three weeks) was observed for GaS; the most reactive were Se-containing monochalcogenides. Surface protrusions appeared after the ambient exposure of GeSe was detected by scanning electron microscopy. In addition, the degradation of GeS and GeSe flakes were observed in the operando experiment in transmission electron microscopy. Further, the amorphization of the material progressed from the flake edges. The reported results and conclusions on the degradation of LMs are useful to understand surface oxidation, air stability, and to fabricate stable devices with monochalcogenides. The results indicate that LMs are more challenging for exfoliation and optical studies than transition metal dichalcogenides such as MoS<sub>2</sub>, MoSe<sub>2</sub>, WS<sub>2</sub>, or WSe<sub>2</sub>.

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