Rapid synthesis of Metal–Organic Chalcogenolates (MOC)

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Metal Organic Chalcogenolates (MOCs)[1] are a new class of van der Waals hybrid organic-inorganic materials. Among them, silver phenylselenide (AgSePh), commonly referred to as *mithrene*, supports ultrastrong light-matter interactions [2] and exhibits distinct excitonic absorption at 2.65 eV and 2.81 eV, along with an emission at 2.62 eV. Similarly, silver phenylsulphide (AgSPh), commonly called as thiorene, shows absorption at 3.2 eV and emission at 3.02 eV. These optical properties make MOCs promising candidates for blue- or UV-based photodetectors [3]. For effective device integration, the synthesis and processing of MOCs must remain within the thermal budget required for back-end-of-line integration. However, time-consuming synthesis routes significantly limit their scalability. In this work, we develop a rapid, solution-based synthesis method by mixing a silver precursor solution with organic chalcogen precursor solutions (Figure 1a), resulting in crystal formation within a short time. X-ray diffraction confirms the phase purity of the crystals, while UV–vis spectroscopy reveals their characteristic optical absorption. In addition to mithrene, we also develop a new vacuum-based synthesis technique for thiorene, yielding crystals within one hour. This study elucidates the underlying mechanisms enabling rapid formation and low-temperature scale-up toward thin-film growth of MOCs. Notably, certain polar aprotic solvents do not exhibit instantaneous crystal formation (Figure 1b), leading us to propose a mechanism governing the rapid synthesis process.

References

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Figures

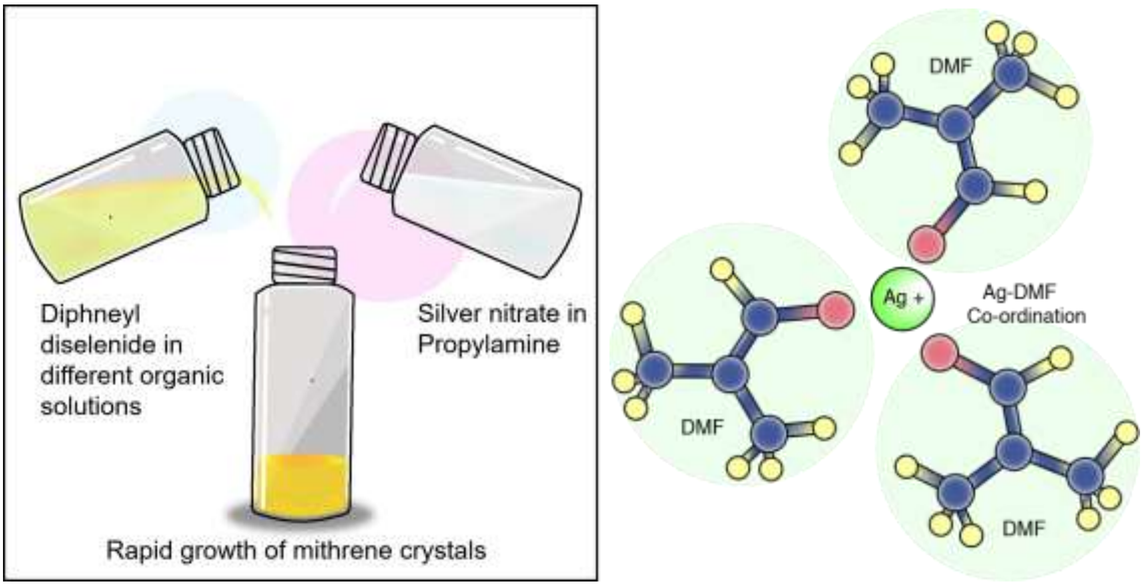

Figure 1. (a) Schematic illustration of the synthesis of Milthrene. (b) Proposed mechanism for solvents that do not support rapid synthesis.