# X-ray diffraction reveals a new deposition mechanism for Powder Aerosol Deposition of films derived from layered crystalline materials

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Powder aerosol deposition (PAD) is a coating process that can be used to produce dense ceramic films at room temperature. In this process, a powder is mixed with a carrier gas, and this aerosol-gas mixture is then accelerated through a nozzle and strikes a substrate inside a vacuum chamber. Upon impact with the substrate, the particles break apart and consolidate into a dense ceramic film through room-temperature impact consolidation (RTIC). This process takes place entirely at room temperature, and no phase change occurs during deposition [1].

PAD films are typically characterized by a nanocrystalline microstructure, high microstrain, and intrinsic compressive stress. Our studies have shown that materials with a layered crystal structure and preferred slip systems in the basal plane exhibit a different microstructure and, as a result, must also have a different deposition mechanism.

These materials form films with a grain size exceeding 1 µm and exhibiting a strong fibrous texture. Furthermore, the microstrain in these films is less than half that of other materials, and no intrinsic compressive stress is present.

The poster illustrates the microstructural differences between typical PAD films and PAD films made from materials with a layered crystal structure (thermoelectric $Bi_2Te_3$ and $Ca_3Co_4O_9$) based on investigations using lab XRD devices and measurements at the P02.1 beamline at DESY in Hamburg, as well as SEM images, and presents a deposition mechanism according to Fig. 1 for these materials.

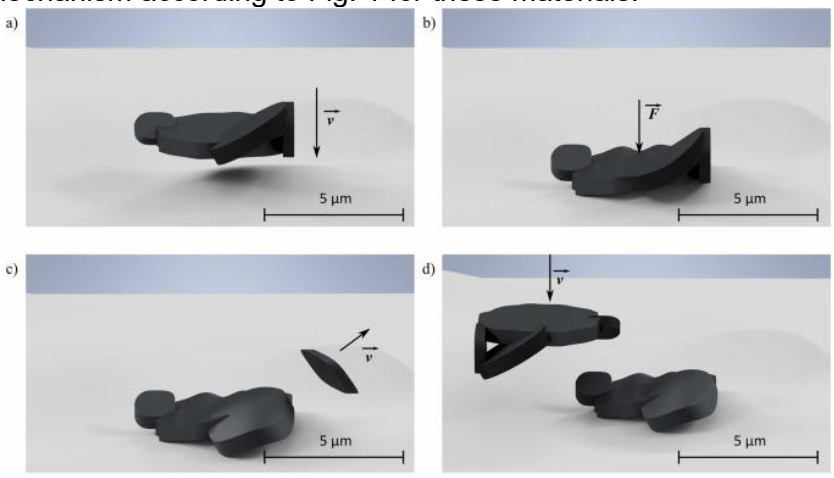



Figure 1. Proposed precipitation mechanism for calcium cobalt oxide as a representative of materials with a layered crystal structure. Figure after [2] © Paulus et al. / CC BY 4.0.

[1] J. Akedo, J. Ceram. Soc. Jpn. 128 (2020) 101–116.
[2] D. Paulus, et al., J. Europ. Ceram. Soc. 46 (2026) 118127.

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