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BiOCl Nanosheets Supported onto Borosilicate Glass Prepared Using the AACVD Method

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Nanostructured bismuth oxychloride (BiOCl) has been extensively employed as a pigment for paints and cosmetics [1]. Additionally, this material is being explored for applications that include the fabrication of electrodes for ion batteries [2], photocatalysts for water treatment, flame retardant materials and UV-A photodetectors [3]. According to the literature, BiOCl can be prepared using different synthesis methods with various levels of complexity. However, most of the techniques often require the use of hazardous chemicals or demand the utilization of long incubation periods and heat treatment processes [4].

This work reports the facile synthesis of BiOCl nanosheets onto borosilicate glass substrates using the aerosol-assisted chemical vapor (AACVD) deposition method. The nanostructured BiOCl fabrication was achieved in one step using a precursor solution consisting of bismuth chloride dissolved in acetone, and the concentration of the solution was 0.05 mol dm^{-3}. Bare borosilicate glass slides with dimensions of 25 mm x 75 mm were used as substrates and were kept at a temperature of 723 K. An ultrasonic nebulizer was employed to produce fine droplets of the precursor solution, which were conveyed to the vicinity of the substrate using filtered and dry air injected at 5 dm^3 min^{-1}. The aerosol was delivered to the substrate using a mobile nozzle, which served to scan the entire length of the substrate at a rate of 25 mm min^{-1}. Thus, the growth of BiOCl nanosheets was achieved in about 3 min.

Grazing incidence x-ray diffraction allowed to define of the crystalline structure of the material formed at the surface of the borosilicate glass. According to Fig. 1a, the diffraction peaks obtained from the sample matched with the growth of tetragonal BiOCl, as indicated in JCPDF Card 01-085-0861. The sharp and intense peaks suggested the formation of large crystallites. No other parasitic phases were detected on the sample. Raman spectroscopy was used to further investigate the microstructure and composition of the prepared material. As noted in Fig. 1b, three main signals at around 150, 206, 399 cm^{-1} were identified. These peaks matched with Raman modes characteristic of BiOCl, as reported in other works [5]. Raman peak at 150 cm^{-1} corresponds to emissions from A_{1g} modes associated with Bi-Cl; peak at 206 cm^{-1} was attributed to contractions of the Bi-Cl bonds, and signal at about 399 cm^{-1} matched with vibration modes for Bi-O. The secondary electron micrograph in Fig. 1c revealed the formation of a uniform layer of material extending along the surface of the substrate. The coating consisted of interconnected squared-like sheets, with average dimensions of 780 ±61 nm of length/width and 160 ±70 nm of thickness. The nanosheet morphology is usually observed on tetragonal BiOCl.

This work displayed the feasible fabrication of a coating consisting of BiOCl in one step using the AACVD method. The synthesized coating was formed by a collection of crystalline and squared-like nanosheets of different sizes, which appeared interconnected. Although the nanosheets displayed variations of orientation and size, the overall coverage of the substrate was uniform and homogeneous.

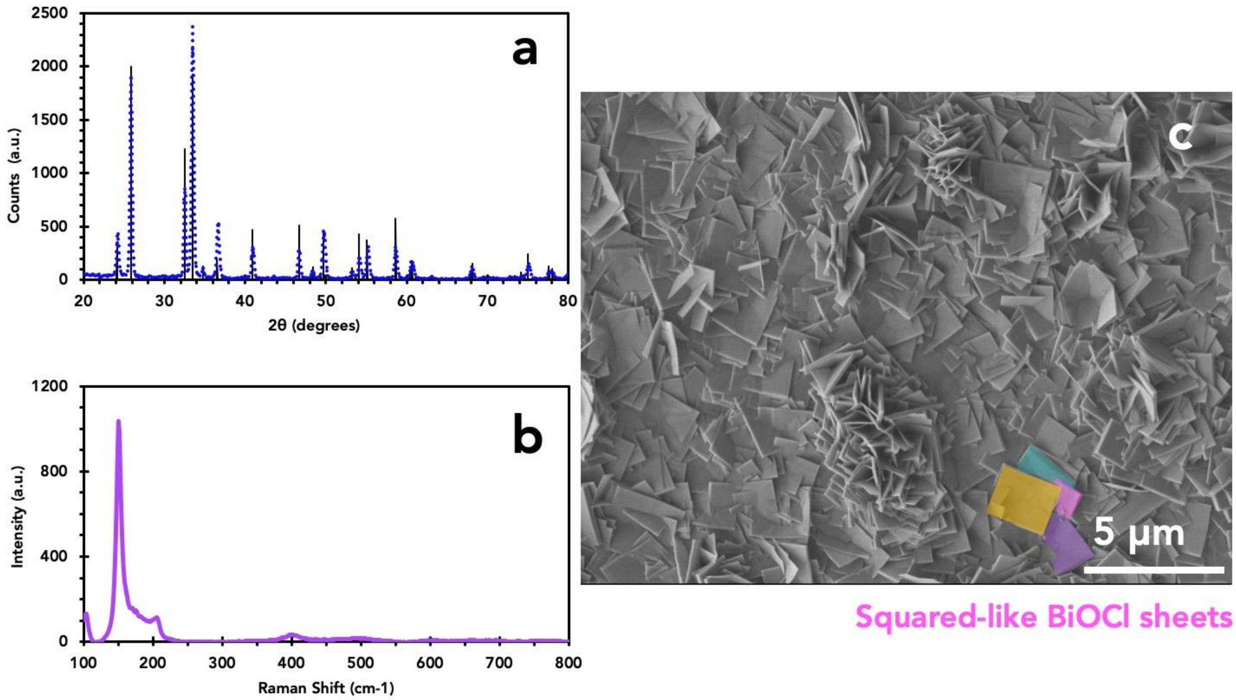

Figure 1. Different characterization methods were used to investigate the microstructure and composition of the fabricated BiOCl coatings. a) x-ray diffraction pattern showing the growth of a highly crystalline material identified as BiOCl; b) Raman spectra confirming the composition of the coating, and c) secondary electron micrograph revealing the morphology, distribution, and size of the nanosheets.

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