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Application of secondary electron hyperspectral imaging to the analysis of pharmaceutical materials

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Background

The importance of pharmaceuticals to the health and wellbeing of society is clear, and it is of upmost importance to have reliable characterisation techniques applicable to the pharmaceutical manufacturing process. Pharmaceutical materials are often complex mixtures, containing multiple organic and possibly inorganic components. The stability and longevity of tablets can be increased through the addition of a coating, and this is evident in many commercially available pain relief medications. The effectiveness of the coating is linked to its surface coverage, and nanoscale characterisation is useful to determine this.

Secondary electron hyperspectral imaging (SEHI) is a recently developed novel electron microscopy technique that provides enhanced surface characterisation. Spectra sensitive to composition, chemical bonding and structure can be formed by collection of the secondary electrons that are emitted from a material following irradiation by an electron beam in the SEM. A variety of materials have been examined by SEHI, not limited to perovskites [1], polymer blends [2] and biomaterials [3], and various carbon materials [4]; however, the technique has not previously been applied to pharmaceutical materials.

Methods

SEM images and SEHI were collected using an FEI Helios G4 CX, a dual beam scanning electron microscope. The hyperspectral images were collected using a monochromated 1 kV accelerating voltage, a typical vacuum pressure of 10^-6 mbar, and a range of probe currents. Complimentary EDX spectroscopy has been undertaken using an Oxford Instruments 150 mm² EDX detector. An example commercially available pain relief tablet, Nurofen Plus, has been examined, in addition to reference materials ibuprofen, anatase and rutile. Samples have been prepared by both embedding in Field's metal and by FIB-prepared lamellae.

Results

Sample preparation is a particular challenge in this work, with the non-conductive pharmaceutical samples charging and causing anomalous features in the produced secondary electron spectra. Various sample preparation methods have been compared, each with advantages and disadvantages, with guidance from previous work with sample preparation of powder materials

utilised [5]. The chosen commercially available pain relief tablet has a coating containing an inorganic pigment (TiO_2) which has led to the analysis of the different structures, anatase and rutile. The applicability of SEHI to the damage and integrity of the coatings has been examined, to assess this technique for the nanoscale characterisation of formulated pharmaceutical products.

Conclusions
In conclusion, this work will present the first analysis of pharmaceutical materials by secondary electron hyperspectral imaging. The advantages and challenges associated with this technique when applied to these materials will be detailed.

Keywords:

SEM; SEHI; pharmaceuticals

Reference:

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