A simple Gandolfi attachment for a Debye–Scherrer camera and its use in a forensic science laboratory.

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Abstract

A device to convert a Debye–Scherrer powder camera into a Gandolfi camera has been designed and constructed. It is attached to the existing Debye–Scherrer rotating specimen stage rendering conversion from Debye–Scherrer to Gandolfi diffraction mode (and vice versa) a very simple matter. Examples of its use in forensic science are also mentioned.

Specimens of the contact trace variety encountered in forensic casework may consist of organic, inorganic, metallic or polymeric materials, or any combination thereof. Most specimens as such can be analysed quite satisfactorily using standard 114.6 mm diameter Debye–Scherrer powder cameras. However, there are certain instances when specimens are better suited to analysis using a Gandolfi camera (Gandolfi, 1967), usually when they cannot, or should not, for one reason or another be ground into a fine powder (Canfield & De Forest, 1977; Soldate & Noyes, 1947).

Although these instances do not arise with sufficient frequency to warrant the purchase of a Gandolfi camera or the construction of a sophisticated attachment (Moss, Wentworth & Barnea, 1979), when they do arise the need for such a device is imperative. With this in mind a simple attachment has been devised and this paper describes its design, construction and use.

Constructional details

Fig. 1 is a photograph of the device in position inside a Debye–Scherrer powder camera. Brass was used for all the components with the exception of the spindle which is a ground silver steel rod (known as ‘drill rod’ in North...
America). In this illustration the sample (A) is a single crystal mounted on the end of a glass fibre. The bracket (B) is fixed to the Debye–Scherrer specimen stage (C) which has holes tapped to accept 3 mm countersunk screws (D). When the specimen stage is spun as in Debye–Scherrer diffraction mode, the friction between the silicone rubber wheel (E) and the knurled back plate (F) causes the spindle with the Gandolfi specimen holder (G) to rotate. The spindle rotates approximately six times for each rotation of the stage (C).

The component parts of the attachment are shown in Fig. 2 and their dimensions are such that the device will fit a Philips PW1024 powder camera. The major factors which govern these dimensions are the distance between the collimator (H) axis and the camera back plate (F), and the diameter of the hole which accommodates the specimen stage in the back plate (15.5 and 32.0 mm respectively in this model). The specimen stage (C) sits 1 mm proud of the camera back plate (F).

The process of centring a specimen involves trial and error in which the specimen is viewed through the collimator and adjustments made along the Gandolfi spindle direction and also to the Debye–Scherrer specimen stage. The total distance from the bottom of the specimen holder (G) along the spindle axis to the point of intersection with the X-ray beam is 10 mm.

Fig. 3. Powder photographs of sucrose; 1 single crystal in Debye–Scherrer mode; 2 single crystal in Gandolfi mode; 3 standard Debye–Scherrer photograph of pure powdered sucrose.

Experimental results

The device has been used successfully on a number of casework specimens. In one case some very hard greenish crystals were submitted for analysis. They were thought to have come from a grindstone and were too hard to be crushed by mortar and pestle so a single crystal was mounted and photographed using the attachment. The resulting 'powder pattern' clearly identified the crystal as silicon carbide whereas a photograph of the same crystal taken in Debye–Scherrer mode showed an unrecognizable array of spots.

A second case involved a solitary clear single crystal for which a definitive non-destructive method of analysis was required. With the crystal mounted on a glass fibre, a Debye–Scherrer pattern appeared as 1 in Fig. 3 and a Gandolfi pattern as 2. Powder photograph 3 is of pure sucrose, thus identifying unequivocally the unknown single crystal. Each of the three photographs in Fig. 3 was taken with a 2 h exposure to nickel-filtered Cu Kα radiation from a Philips fine-focus X-ray tube powered at 40 kV 30 mA.

Drug/sugar mixtures generally yield Debye-Scherrer photographs showing smooth and spotty lines due to the different crystallite sizes of drug and sugar components respectively. This segregation of lines assists greatly in qualitative identification but when quantitative analysis is required some method of 'smoothing' the spotty lines prior to microdensitometry is essential. The Gandolfi attachment has been used successfully for this purpose but with one disadvantage—line broadening due to the larger area swept out by the motion of the capillary-tube sample in Gandolfi mode.

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References