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Workplace air — Analysis of respirable crystalline silica by Fourier-Transform Infrared spectroscopy

Air des lieux de travail — Mesure de la fraction alvéolaire de la silice cristalline par spectrométrie infrarouge

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 2, *Workplace air*.

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Introduction

Respirable crystalline silica (RCS) is a hazard to the health of workers in many industries through exposure by inhalation. Industrial hygienists and other public health professionals need to determine the effectiveness of measures taken to control workers' exposure. The collection of samples of air during a work activity and then measuring the amount of respirable crystalline silica are often done to assess an individual's exposure, their respiratory protection, or the effectiveness of controls. Fourier-Transform Infrared (FTIR) analysis of crystalline silica in a sample of respirable dust collected on a collection substrate is employed in many countries to measure and estimate exposure to RCS. FTIR is able to measure quartz and cristobalite.

This document specifies the analysis procedures for the measurement of RCS through three methods:

a) Direct-on-filter method: a method of analysing RCS directly on the air sample filter. A specific requirement of this method is that the sampler used for the workplace measurements is the same as that used for the preparation of calibration samples.

b) Indirect method by redeposition: a method whereby the dust is recovered from the collection substrate and deposited onto a filter for analysis.

c) Indirect method by potassium bromide (KBr) pellet: a method whereby the dust is recovered from the collection substrate and pressed into a potassium bromide (KBr) pellet for analysis.

Many different types of sampling apparatus are used to collect respirable dust, according to the occupational hygiene convention. This document is designed to accommodate the variety of samplers and collection substrates available to analysts. This document is used in conjunction with ISO 24095 which promotes best practice for these analyses.

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Workplace air — Analysis of respirable crystalline silica by Fourier-Transform Infrared spectroscopy

1 Scope

This document is a standard for the analysis by Fourier-Transform Infrared (FTIR) of respirable crystalline silica (RCS) in samples of air collected on collection substrates (i.e. filters or foams). Three analytical approaches are described for whom the dust from the sample collection substrate is

a) analysed directly on sampled filter,

b) recovered, treated and deposited onto another filter for analysis, or

c) recovered, treated and pressed into a potassium bromide (KBr) pellet for analysis.

This document provides information on the instrumental parameters, the sensitivity of different sampling apparatus, the use of different filters and sample treatment to remove interference. In this document the expression RCS includes the most common polymorphs quartz and cristobalite.

This document excludes the less common polymorphs of crystalline silica, such as tridymite.

Under certain circumstances (i.e. low filter dust loads, low silica content), the analytical approach described in this method cannot fulfil the expanded uncertainty requirements of ISO 20581. Guidance for calculation of uncertainty for measurements of RCS is given in ISO 24095.

2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7708, *Air quality — Particle size fraction definitions for health-related sampling*

ISO 13137, *Workplace atmospheres — Pumps for personal sampling of chemical and biological agents — Requirements and test methods*

EN 13205, *Workplace exposure — Assessment ofsampler performance for measurement of airborne particle concentrations*

ISO 15767, *Workplace atmospheres — Controlling and characterizing uncertainty in weighing collected aerosols*

ISO 18158, *Workplace air — Terminology*

ISO 24095, *Workplace air — Guidance for the measurement of respirable crystalline silica*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18158 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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3.1 General definitions

3.1.1
respirable crystalline silica
RCS
inhaled particles of crystalline silica that penetrate into the unciliated airways according to the respirable convention described in ISO 7708

3.2 Sampling definitions

3.2.1
analysis filter
suitable filter used to carry out the RCS analysis

Note 1 to entry: For direct-on-filter FTIR analysis the collection substrate is the analysis filter.

Note 2 to entry: For the indirect analysis the dust is removed from the collection substrate and redeposited onto an analysis filter.

3.2.2
collection substrate
medium on which airborne chemical and/or biological agents are collected for subsequent analysis

Note 1 to entry: For the purpose of this document, filters, polyurethane foams and sampling cassettes are examples of collection substrates for airborne particles.

4 Principle

This document provides three Fourier-Transform Infrared (FTIR) analytical approaches for the analysis of RCS in respirable dust collected on a sample collection substrate.

a) Direct-on-filter method:

   The respirable dust on the collection substrate (usually a 25 mm diameter filter) is measured without transferring the dust to an analysis filter. The mass of RCS is determined from the FTIR response, calibrated against filters loaded with known amounts of RCS reference material.

b) Indirect method (redeposition):

   The dust from the sample collection substrate (i.e. a 37 mm diameter filter or a polyurethane foam) is recovered, treated and deposited on another analysis filter (usually 25 mm diameter or smaller) for analysis by the instrument. The instrument is calibrated by preparing test samples from aliquots of a suspension of a reference material. The mass of RCS is determined from the FTIR response, calibrated against analysis filters loaded with known amounts of RCS reference material.

c) Indirect method (KBr pellet):

   The dust from the sample collection substrate (i.e. a 37 mm diameter filter or a polyurethane foam) is recovered, treated and pressed into a KBr pellet for analysis by the instrument. The instrument is calibrated by preparing KBr pellets with known amounts of a reference material. The mass of RCS is determined from the FTIR response, calibrated against pellets loaded with known amounts of RCS reference material.

Since the volume of air sampled is known, the concentration of RCS in the air is readily calculated. Because the different aerosol samplers for respirable dust deposit the sample over the surface of the filter in different ways, the FTIR instruments used for the direct-on-filter analysis approach shall be calibrated for the aerosol sampler used to collect the samples.

The suitability of FTIR to determine the RCS concentration in a workplace sample depends on the composition of the dust and potential interferences. If the FTIR method to subtract a reference spectrum from the sample spectrum (refer to 9.3.2) does not lead to a satisfactory baseline profile, then

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