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Inactivation of SARS-CoV-2 and other coronaviruses by UV-C in the Leica cryostat product family

ADDENDUM to Maier, I (2010): Certificate: Inactivation of bacteria, viruses and other pathogens by UV-C irradiation in the Leica cryostat product family

A family of Leica cryostats is equipped with germicidal UV-C lamps (254 nm) that provide disinfection of the working space in a safe and convenient way. Facing the ongoing SARS-related coronavirus-2 (SARS-CoV-2) pandemic that emerged in December 2019 the question arises, if coronaviruses are effectively inactivated by UV-irradiation in the cryostats.

Coronaviruses (CoV) cause various respiratory and enteric diseases in humans and animals. The genus includes, for example, human coronaviruses (HCoV) that cause mild to moderate respiratory tract infections, porcine epidemic diarrhea virus (PEDV) and canine coronavirus (CCoV). Life-threatening diseases are caused by the Severe Acute Respiratory Syndrome related coronavirus (SARS-CoV), the Middle East Respiratory Syndrome related coronavirus (MERS-CoV) and SARS-CoV-2, the cause of the COVID-19.

In UV-C-inactivation studies, test bacteria and viruses were dried onto stainless steel surfaces, placed in the cryostat working space at - 20 °C and irradiated for various periods of time. As a biodosimetry virus, simian virus 40 (SV40) was inactivated by >4 $\log_{10}$ units by irradiation for 95 to 180 minutes (Maier 2010).

From these experiments and by comparison with literature data on various viruses, predictions can be made on the efficacy of UV-irradiation for inactivation of viruses for which empirical data are lacking. From a literature review, a mean inactivation constant for polyomaviruses of 0.014 ± 0.007 $\log_{10}$ reduction per mJ/cm^2 fluence was deducted, corresponding to about 290 mJ/cm^2 for reduction by 4 $\log_{10}$ units. SV40 is regarded as a highly UV-C-resistant virus (Nims & Plavsic 2013, Maier 2010).

SARS-CoV, MERS-CoV, SARS-CoV-2 and other coronaviruses are large enveloped single-stranded RNA viruses with a genome size of about 30 kb (Lee 2015, Lu et al. 2020, Marra et al. 2003, Rota et al. 2003, van Boheemen et al. 2012). UV-C is absorbed by RNA and causes the photochemical dimerization of adjacent pyrimidines. As a consequence, viral nucleic acid transcription is inhibited (Tyrell et al. 2001, Douki et al. 2003). UV-C efficacy depends primarily on the target size and shielding by other UV-C absorbing material. It is to be expected that the coronaviruses mentioned above are similarly susceptible to UV-C radiation.

Data by Kariwa et al. (2006) showed inactivation of SARS-CoV by about 5 $\log_{10}$ units after exposure to 120 mJ/cm^2. In a THERAFLEX UV-Platelets pathogen inactivation system (Macopharma, Tourcoing, France) and spiked platelet concentrates, Eickmann et al. (2018, 2020) achieved inactivation of MERS-CoV by ≥3.7 $\log_{10}$ units $TCID_{50}$ with 150 mJ/cm^2 and SARS-CoV by ≥3.4 $\log_{10}$ units $TCID_{50}$ with 200 mJ/cm^2, respectively. Inactivated porcine transmissible gastroenteritis virus (TGEV) was obtained by a UV-C dose of 100 mJ/cm^2 (Wang et al. 2018) and porcine epidemic diarrhea virus (PEDV) at 120 mJ cm^2 (Gao Q et al. 2016). Bedell et al. (2016) showed MERS-CoV surface disinfection by >5 $\log_{10}$ units using an automated whole-room UV-C irradiation system but gave no information of the UV-C dose applied. In thick preparations, higher doses are required: Darnell et al. 2004 reported inactivation of SARS-CoV by 5 $\log_{10}$ units $TCID_{50}$ by about 1,4 J/cm^2 in tissue culture medium of 1 cm depth.

It conclusion, SARS-CoV-2, SARS-CoV and MERS-CoV are regarded as less resistant to UV-C radiation than SV40, the reference virus. It can thus be safely assumed that irradiation in the cryostat for three hours (CM1850UV/CM1860UV/CM1950) and four hours (CM1900UV), respectively, reduces coronavirus contamination by at least 4 $\log_{10}$ units.

However, virus inactivation is restricted to directly irradiated areas and virus particles not shielded by other material. Therefore, UV-C irradiation cannot replace regular chemical disinfection of the cryostat chamber.

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Amtzell, 7 April 2020 PD Dr. Ingo Maier