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Development of a Mobile SEM Enclosure Based on Biological Containment Concepts

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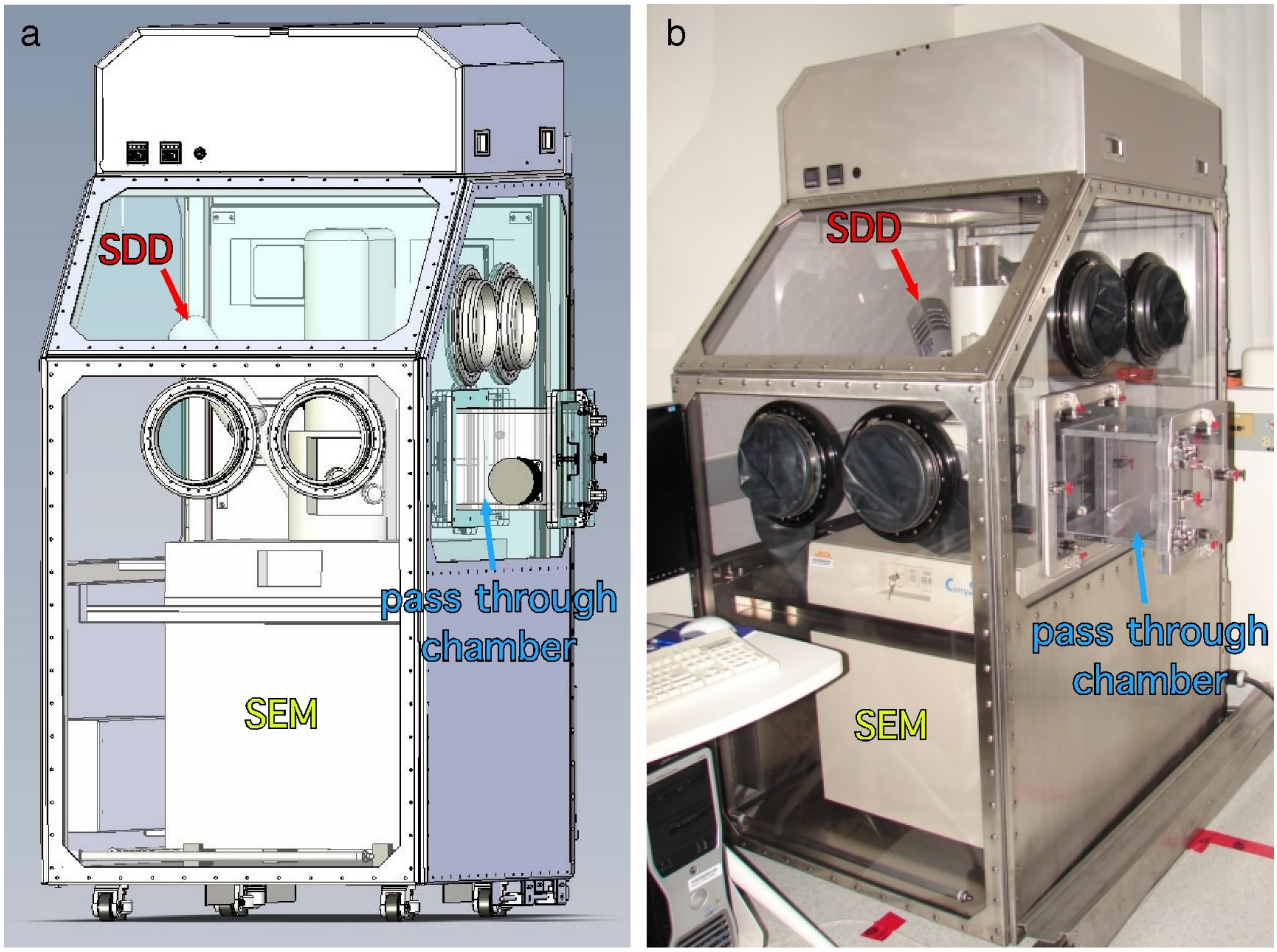
One of the key considerations in rapid diagnostics of infectious materials is the ability to accurately identify a specimen, and provide optimal protection for the staff performing the tests. In the event of a disease outbreak, or an intentional release of a bioagent the results of these tests are extremely time sensitive. Nucleic acid based procedures are rapid and extremely accurate; however additional information on the structural and chemical composition of an agent can be crucial in the identification process. This chemical data will help ascertain if the specimen being investigated could be naturally occurring, or a man made agent. Brewer et al., [1] recently utilized microanalysis techniques in the chemical characterization of simulated bioagents.

In this abstract we outline the development of a mobile enclosure produced for a JCM-5700 Carryscope (JEOL, Inc.) scanning electron microscope (SEM), equipped with an X-max 80 mm^2 X-ray microanalysis system (Oxford Instruments). This novel project involved the combination of three well-established pre-existing technologies; scanning electron microscopy, biological containment, and X-ray microanalysis. These three technologies required additional capabilities in order to be used in concert. The SEM had to be; mobile so that it could be rolled into the enclosure, and all operational functions of the microscope had to be computer controlled. The X-ray microanalysis system had to be fully automated (motorized insertion of detector), and the detector had to be a silicon drift detector (SDD) which uses Peltier cooling instead of liquid nitrogen. Finally the enclosure itself had to be; mobile, a closed system that operated under negative air pressure, have a specimen pass-through chamber, have an electrical feed-through, HEPA filter exhaust, vaporous hydrogen peroxide decontamination system, and have a vibration free cooling system that could compensate for the heat produced by the X-ray detector and SEM. When assembled the entire system must be mobile, and be able to fit through a standard 42 inch door. This allows the entire system to be shipped and relocated to a pre-existing location with minimal relocation/renovation requirements for the system to be operational.

We have successfully designed and fabricated an enclosure which meets all of our requirements, and we have begun preliminary trials with the system. The benefit of this system is that it enables us to safely analyze potentially infectious specimens in a timely fashion using a closed biological containment enclosure. Since the SEM and X-ray microanalysis system are computer controlled the enclosure has minimal impact on the standard operation of the equipment. The enclosure was designed with a pass through chamber and two glove ports for specimen exchange. The glove port above the pass through chamber has the additional functionality to be used for both condenser aperture alignment, as well as Wehnelt assembly replacement. This permits both SEM operation and electron gun replacement while maintaining full containment.

References

[1] L.N. Brewer et al., Forensic. Sci. Int., 179 (2008), 98.



Images of the SEM Enclosure. (**a**) Final design of the SEM enclosure. The enclosure was conceived to be both mobile, and to be able to accommodate a JEOL Carryscope JCM-5700 equipped with an Oxford Instruments X-max 80 mm^2 silicon drift detector. (**b**) Final fabricated SEM enclosure. The enclosure was built with an alloy frame with transparent polycarbonate walls which provide maximum visibility. The enclosure also monitors internal temperature and air pressure while the system is operational.

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