LVEM for Virology

Background

This report will present how LVEM benefits research and scientific advancements in the field of virology.

Electron microscopy is an excellent approach for obtaining micrographs of virus structure and morphology, given their size range is typically 5 nm to 300 nm. (Kaiser, 2021) Indeed, Transmission Electron Microscopy (TEM) has been used since the 1960's as a diagnostic tool for identifying viruses in biological suspensions or tissue sections, and TEM continues today to serve for diagnosis when molecular assays cannot provide answers. (Roingeard, 2019) In the context of modern biology it has long been known that low voltage electron microscopy (LVEM) can "empower us to extract even more information from samples." (Chatterjee, 2012).

Electron Microscopy in Virology

Historically, diagnostic EM required transmission electron microscopes that are very expensive, require large dedicated physical spaces and dedicated technical expertise for their successful operation. Recent reports demonstrate how lower accelerating voltages improve transmission electron microscopy of viruses, including low voltages of 5 kV afforded by an LVEM 25 or LVEM 5. (Möller, 2020). For example, Figure 1 illustrates how LVEM performs when imaging yellow fever virus (flavivirus), and vaccinia virus. Reports have even successfully imaged human rotovirus in complex matrices or 'dirty' samples, where the characteristic wheel shape morphology of the virus can be diagnosed. LVEM has also been used to image SV40 virus particles inside the secretory granules of pancreatic cells. (Bendayan, 2008)

LVEM 25 Enhanced Contrast

The LVEM microscopes offer enhanced contrast of biological samples compared to traditional TEM, directly on the as-prepared samples. This often eliminates the need for heavy metal staining of biological samples, creating a safer operating experience. The enhanced contrast of low atomic weight atoms including carbon, nitrogen, oxygen commonly comprising the composition of biological materials enables clear visualization of virus structures.

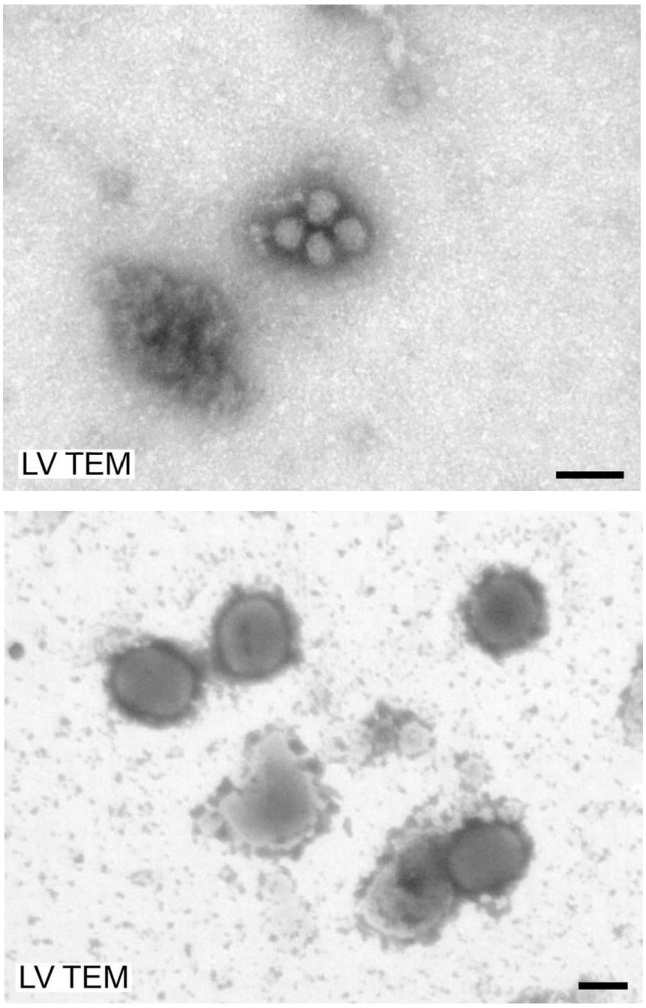

Figure 1. Top, yellow fever virus (flavivirus), and bottom, Vaccinia virus (Orthopoxvirus). Reproduced from (Möller, 2020)

A direct comparison of multiple electron microscopy techniques used to evaluate vaccinia virus samples reveals LVEM is strongly suited for virology studies. (Figure 2). As was similarly found during clinical validation of pathology samples, the LVEM 25 is strongly suited as a compact and affordable TEM option for both medical and research laboratories. (Lawrence, 2020)

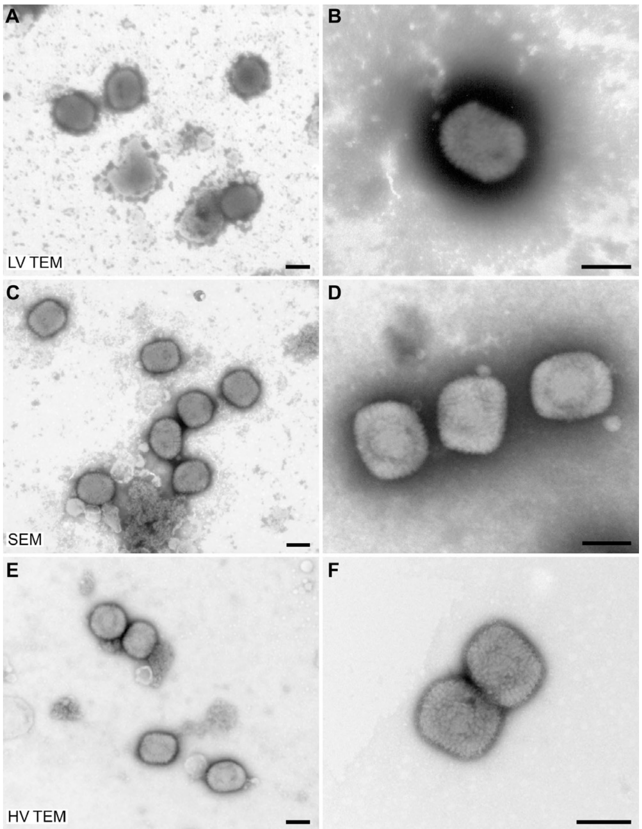

Figure 2. Vaccinia virus (orthopoxvirus) from vero cell culture, imaged by (A, B) LVEM 25 (LV TEM) , (C, D) TeneoVS (SEM), and (E, F) JEM-2100 (HV TEM). Reproduced from (Möller, 2020)

Thoughtful sample preparation for LVEM can improve final image quality, especially when imaging virus-containing samples. For example, when using carbon support films, selection of films that are 10 nm thick instead of 30 nm thick will significantly increase electron transmittance. The benefits of this include improved image quality, reduce risk for sample dehydration effects, more reproducibility in sample preps, and reduced chromatic aberration from non-elastic scattering of the incident beam in the sample. (Sintorn, 2013)

LVEM

The LVEM 25 provides a versatile tool for diagnosing viruses. For either a research biology or a hospital pathology laboratory manager, there are several well-established operational and business advantages to LVEM compared to traditional TEM instruments to help meet the demands for high quality facilities competing for limited resources, and meet the goals of providing cost-effective approaches.

LVEM Financial & Operational Advantages vs HVTEM:

- Lower initial cost
- Lower operating cost
- Easier operation
- Easier maintenance
- Smaller laboratory footprint
- No specialized site prep required

The significantly lower initial cost of a new LVEM instrument compared to even a used TEM is a tremendous advantage, allowing routine access to electron microscopy images when otherwise unobtainable and freeing up larger budgets for other critical tasks.

Additionally, placement of an LVEM is possible in many laboratories, making for much more efficient collection of routine characterization data. Much as low-cost instruments are ubiquitous in synthesis labs for initial screening characterization, LVEM enables electron microscopy to now become a rapid, affordable and easy microscopy tool, eliminating the need for costly core user facilities often found only at major research universities.

Conclusion

LVEM is an enabling technology for the widespread deployment of EM for virology. Compared to traditional high voltage TEM, LVEM offers benefits including lower costs, easier operation, and rapid results. Clinical validation of pathology samples has demonstrated the LVEM 25 is strongly suited as a compact and affordable TEM option for both medical and research laboratories.

The world's best low voltage electron microscope, the Delong LVEM 25, continues to contribute to many scientific disciplines beyond pathology, including nanotechnology, cell biology, materials science, higher education, environmental toxicology, and energy research.

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About the author:

Robert I. MacCuspie, Ph.D., has over twenty years of experience in nanotechnology and materials characterization. Career highlights include leading the team that developed the silver nanoparticle reference materials at the National Institute of Standards and Technology, the first faculty and Director of Nanotechnology and Multifunctional Materials Program at Florida Polytechnic University, and over five years of consulting at the business-science interface from MacCuspie Innovations, helping companies commercialize and educate on technologies to improve human health.