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doi:10.1017/S1431927621006036
Microsc. Microanal. 27 (Suppl 1), 2021

Design and Construction of a Custom-Made and Inexpensive Glow Discharge System for TEM Applications

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The use of clean and consistent quality grids is very crucial due to highly demanding imaging applications using transmission electron microscopy (TEM). Since the TEM grids and carbon coated support materials typically tend to be hydrophobic, they need to be pretreated prior to the sample preparation and imaging stages. Therefore, the glow discharge systems are commonly used to clean the TEM grids via selective removal of adsorbed hydrocarbons, and thus, to make them hydrophilic in the reduced atmosphere of air [1]. The glow discharge treatment of TEM carbon support films modifies the wettability and results in negative surface charge (hydrophilic), which is key for the easy spread of aqueous solutions [2,3]. However, such glow discharge systems are known to be expensive. In this work, a custom-made and inexpensive glow discharge system was designed and built based on the design and study reported by Aebi and Pollard (1987) [4]. As displayed in Figure 1, a typical small-volume, plastic desiccator (A) was used as a vacuum chamber for the glow discharge unit. Top electrode (D1) and bottom electrode (D2) both having 95 mm diameter and 6 mm thickness were prepared by machining of the 6061 aluminum disc based on a drawing created in Solid Works software. The bottom aluminum electrode was then mounted on a threaded brass rod and fixed into its position using an electrically insulating and wear resistant acetal plastic washer. A flexible copper wire (H) was then attached to the bottom electrode for full grounding, which is critical for proper glow discharge application. Additionally, an aluminum rod with 13.1 mm diameter, 150 mm length and threaded end was machined from a 6061 aluminum material. This rod (C) specifically designed as an alternative electrode tip of the high-frequency coil (B) was then connected to the top electrode (D1). In addition, a 10 mm needle-type valve (F) was attached to the bottom section of the desiccator for partial evacuation. A micrometric capillary valve (E) was connected to the air inlet nozzle located in the upper section of the desiccator for a controlled and slow air flow. It should be also noted that all the parts connected or attached to the desiccator were vacuum-sealed using an epoxy adhesive. Prior to the operation of the custom-built glow discharge system, TEM grids were placed on a rectangular aluminum grid carrier (G), and then transferred onto the bottom electrode. The vacuum chamber was then evacuated for 2-5 min. Afterwards, the high-frequency coil was turned on using its adjustment knob in order to generate an intense purple-to-violet glow discharge between two parallel electrodes. The typical discharge time of the carbon films on TEM grids is 5-15 seconds, which may need to be adjusted depending upon the initial results for the optimized performance. The design and construction of a custom-made, simple and inexpensive glow discharge system can be highly beneficial for researchers and for multi-user facilities in need of cost-effective solutions for transmission electron microscopy applications.

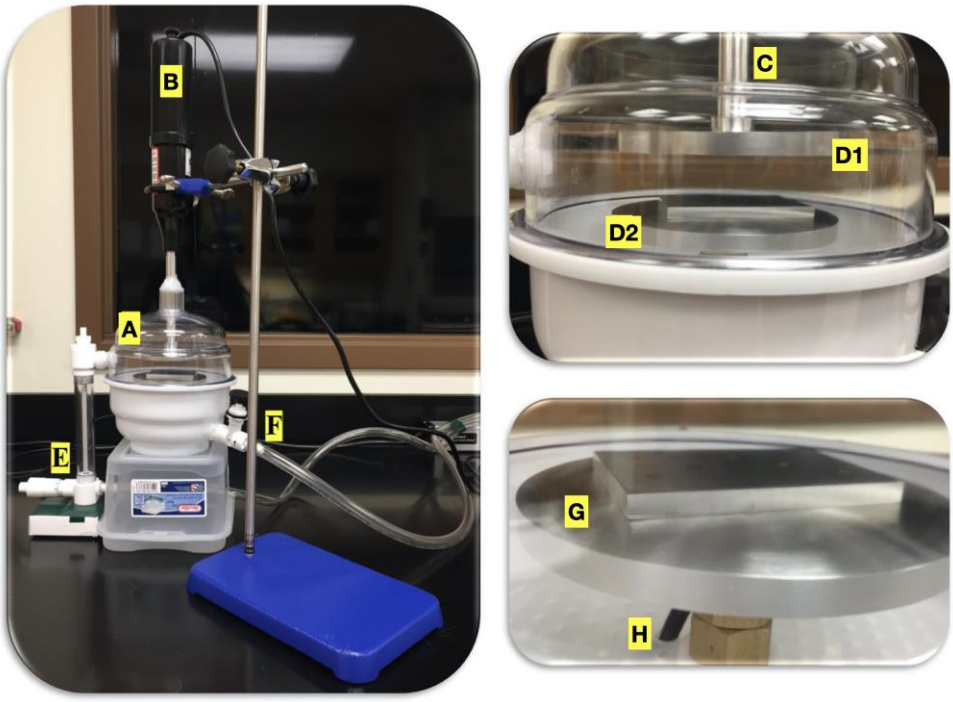

Figure 1. Photograph of the custom-built glow discharge system: (A) plastic vacuum desiccator, (B) high-frequency coil, (C) aluminum rod as an electrode tip of the coil, (D1-D2) top and bottom aluminum electrodes, (E) micrometric capillary valve, (F) needle-type evacuation valve, (G) aluminum grid carrier, and (H) copper grounding wire.

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https://doi.org/10.1017/S1431927621006036 Published online by Cambridge University Press