In the slow switching mode, the switching times for LC cell with graphene conducting layer (23.2 ms in the visible range) and ITO electrodes (240 ms) are shown in Fig. 7a and 7b, respectively. The slow switching mode is characterized by a decrease in the rate of change of light intensity with increasing voltage, which indicates a reduction in the speed of the switching process.

During the fast switching mode, the switching times for LC cell with ITO and graphene layers are 0.66 ms and 0.6 ms, respectively, and relaxation times are 240 ms (ITO) and 200 ms (graphene). The fast switching mode is characterized by a rapid increase in the rate of change of light intensity with increasing voltage, which indicates a faster switching speed.

**Conclusion**

Hybrid graphene-ITO nematic LC devices have been investigated to characterize graphene’s electronic, optical, and dynamic characteristics. The optical switching time characteristics of LC cells with graphene are slightly worse than those of cells with ITO. However, hybrid graphene-ITO devices are promising candidates for applications in various photonic devices that require conducting and transparent thin film electrodes. Further research is needed to optimize the fabrication process and to study the long-term stability of these devices.

**References**