# Synthesis and Characterization of Azo-Based Cyclotriphosphazene Compounds: Liquid Crystalline and Dielectric Properties


## ABSTRACT

The study examined the chemical structure of azo-based liquid crystalline compounds that were altered to form a branch of cyclotriphosphazene. Moreover, the research explored the interplay between their mesomorphic and dielectric properties. The structures of the compounds were defined by Fourier transform infrared spectroscopy, nuclear magnetic resonance spectroscopy, and CHN elemental analysis. Only intermediates 2a–e and cyclotriphosphazene compounds 4d–e were mesogenic with smectic A (SmA) and smectic C (SmC) phases, respectively. Intermediate 2d and compound 4d were used as representative samples to determine the type of liquid crystal, which was confirmed through X-ray diffraction (XRD). The calculated d/L ratios for both compounds were 1.69 and 0.76, respectively, indicating that d was approximately equal to L ($d \approx L \approx 1$). This finding suggests that the SmA and SmC phases observed under polarized optical microscope (POM) are arranged in a monolayer. For the dielectric study, only compounds 2d–e and 4d–e were proceeded and compared for dielectric characteristics testing. The dielectric constants and dielectric loss factors of these four compounds were measured over the frequency range of 100 Hz to 0.1 MHz at room temperature. The dielectric constant trend decreased with the increasing frequency. Meanwhile, the dielectric loss showed two types of trends. The first trend was identical to the dielectric constant trend, in which the dielectric loss decreased as the frequency increased. However, in the second trend, the dielectric loss began to rise with the increase in frequency and then began to fall gradually after reaching a certain peak. Meanwhile, compounds 4d and 4e had low dielectric constants and losses due to the effect of hexasubstituted cyclotriphosphazene that had been attached as a core.