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论文

基于几何遮蔽效应和法拉第旋光效应耦合的磁流体偏振光透过率

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摘要:

根据几何遮蔽效应和法拉第旋光效应耦合原理给出的解析表达式,通过数值模拟计算,研究了磁流体的纵场诱导偏振光透过率及磁流体的浓度、液态介电常量、磁性颗粒磁偶极矩热能比和单位磁性颗粒团聚体所含磁性颗粒数量四个参量的变化对其偏振光透过率的影响.结果表明,磁流体的浓度、液态介电常量和磁性颗粒磁偶极矩热能比对其偏振光透过率有显著影响,低浓度样品的偏振光透过率随着纵向磁场强度的增大而线性增加,而高浓度样品则随着纵向磁场强度的增大呈现振荡变化的特性.在一定范围内,磁流体偏振光透过率随其液态介电常量$\varepsilon_{\mathrm{liquid}}$和磁性颗粒磁偶极矩热能比$\mu_d/(kT)$的变大而增加.而单位磁性颗粒团聚体所含磁性颗粒数量对其偏振光透过率没有影响,磁流体参量依赖的偏振光透过率在低磁场区域和高磁场区域有明显区别.提出了磁流体纵场诱导偏振光透过率在几类光子器件中的可能应用.

关键词: 磁流体 几何遮蔽效应 法拉第旋光效应 光学透过率 光子器件

Title Polarized Light Transmittance of Magnetic Fluids Assigned to the Coupling of Geometric Shadowing Effect and Faraday Rotation Effect

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Abstract:

The polarized light transmittance of magnetic fluids under longitudinal magnetic field and the influence of magnetic fluids concentration, dielectric constants of the remanent liquid phase within the magnetic fluids, the ratio of dipole moment to the thermal energy of single magnetic nanoparticle and the number of magnetic nanoparticles per agglomeration are investigated numerically according to the analytical expression when considering both the geometric shadowing effect and the Faraday rotation effect. Theoretical results indicate that the magnetic fluids concentration, dielectric constants of the remanent liquid phase within the magnetic fluids and the ratio of dipole moment to the thermal energy of the single magnetic nanoparticle affect the polarized light transmittance apparently. The polarized light transmittance of magnetic fluids increases linearly or oscillates with the strength of the longitudinal magnetic field for low or high concentration samples, respectively. In certain ranges, the polarized light transmittance of magnetic fluids increases with dielectric constants of the remanent liquid phase and the ratio of dipole moment to the thermal energy of single magnetic nanoparticle. While the polarized light transmittance is almost independent of the number of magnetic nanoparticles per agglomeration. The distinct difference of the parameter-dependent polarized light transmittance at low and high magnetic field regions is obtained. The applications to several photonic devices based on the polarized light transmittance of magnetic fluids under longitudinal magnetic field are proposed.

Keywords: Magnetic fluid Geometric shadowing effect Faraday effect Light transmittance Photonic devices

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