

# Two-wave mixing in liquid crystal doped with hydrogen-bonded azo-dye-polymer complex

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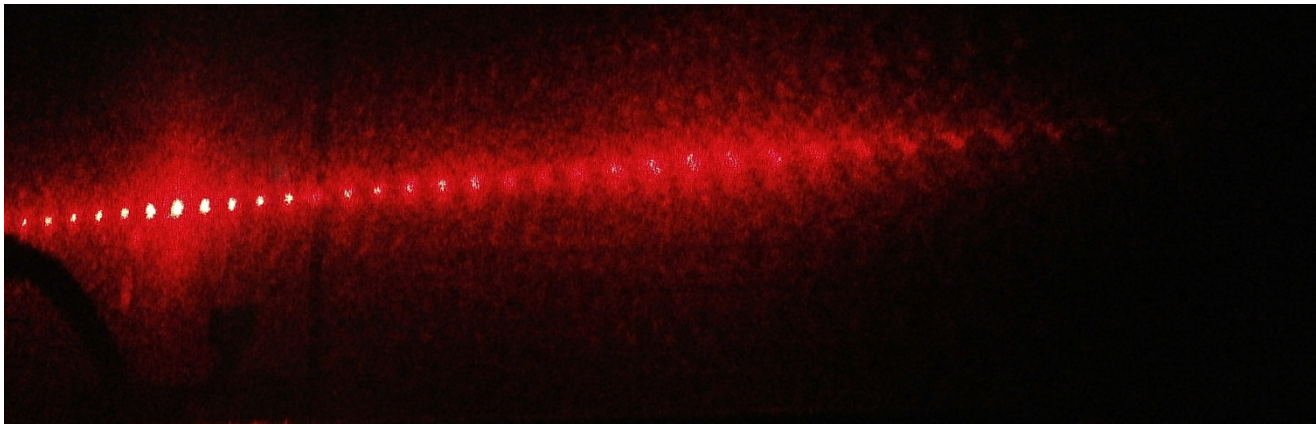


# Introduction

Fundamental research of new optical materials



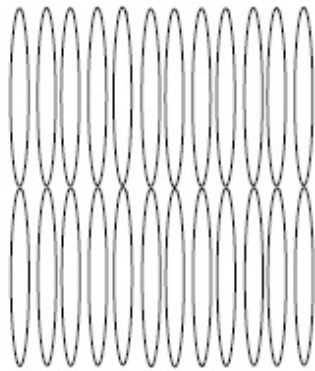
Optical and physical properties of a novel complex-doped liquid crystalline solution



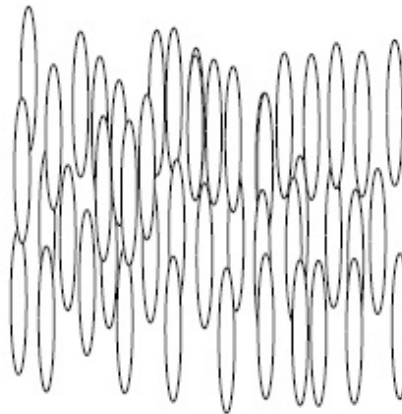
# Theoretical background

## Liquid crystals

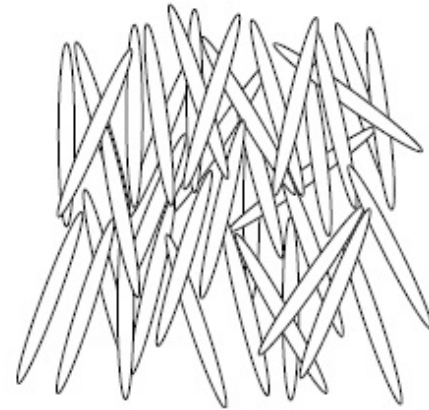
- Properties of both liquid and solid materials
- Diverse optical properties and many phases



(a) Crystalline



(b) Nematic

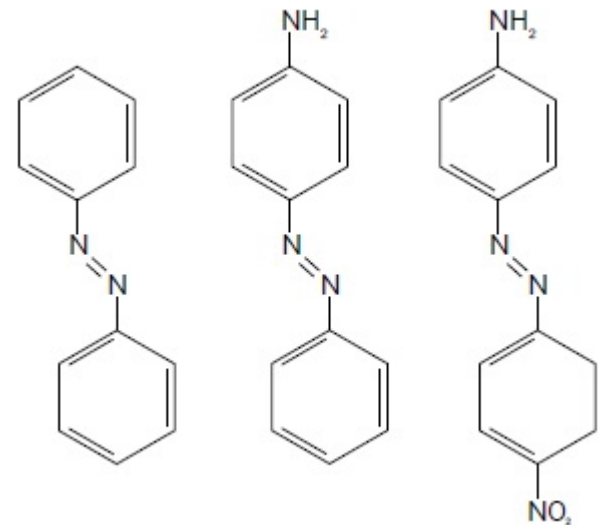
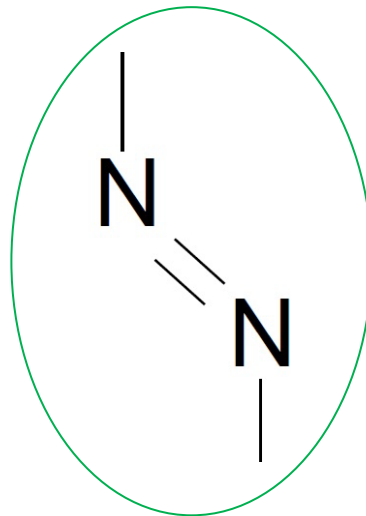


(c) Isotropic

# Theoretical background

## Azo-dyes

- Phenyl rings linked with an azo bond
- Side groups affect absorption bands

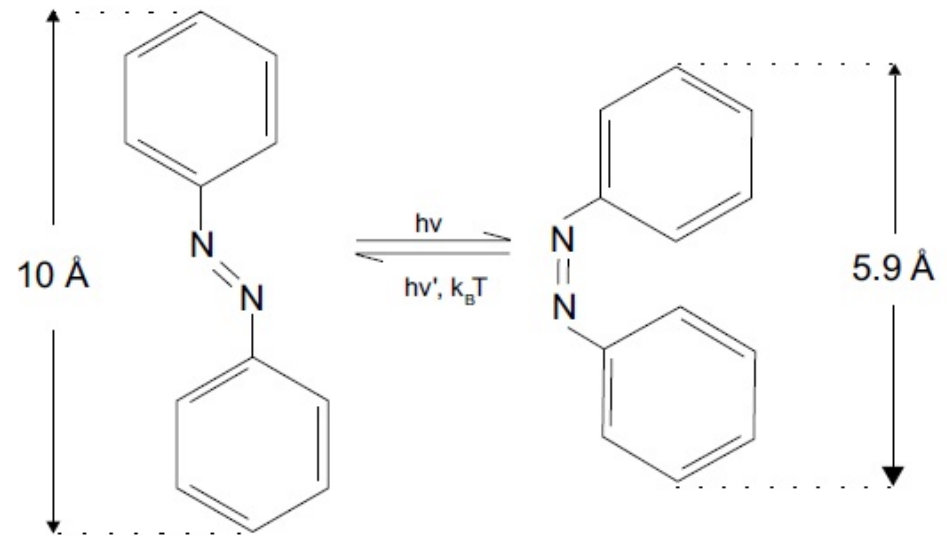


# Theoretical background

## Azo-dye photoisomerization

– *Trans* - *cis* isomerization along the azo bond

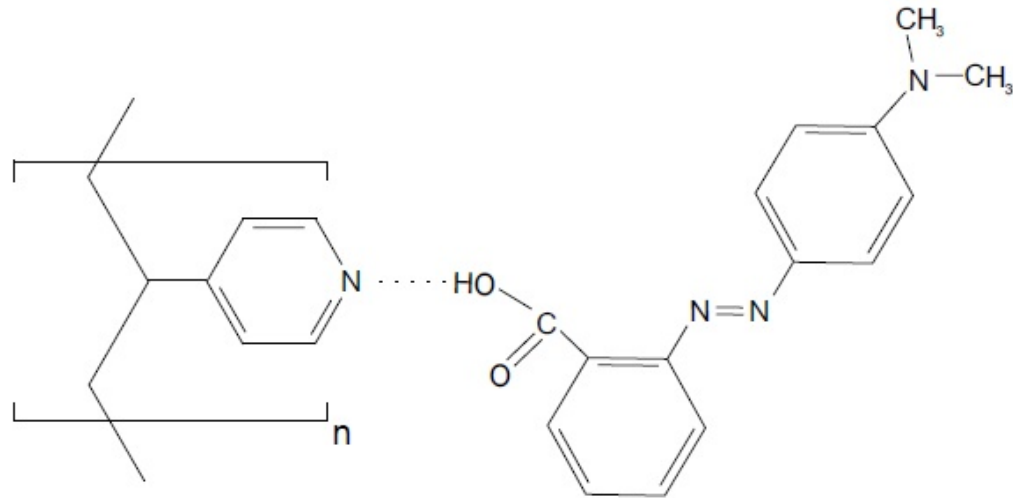
- 1) Reorientation of molecules
- 2) Photoinduced motions



# Theoretical background

## Studied solution

- Azo-dye Methyl Red (MR) bonded into P4VP
- $5\text{CB} + 0.5\% \text{P4VP(MR)}_{0.5}$



# Experiments

## Characterization of 5CB + 0.5% P4VP(MR)<sub>0.5</sub>

- Absorbance
- Holography grating recording



Compared with pure 5CB and  
MR-doped 5CB

# Experiments

## Holography grating recording (HRG)

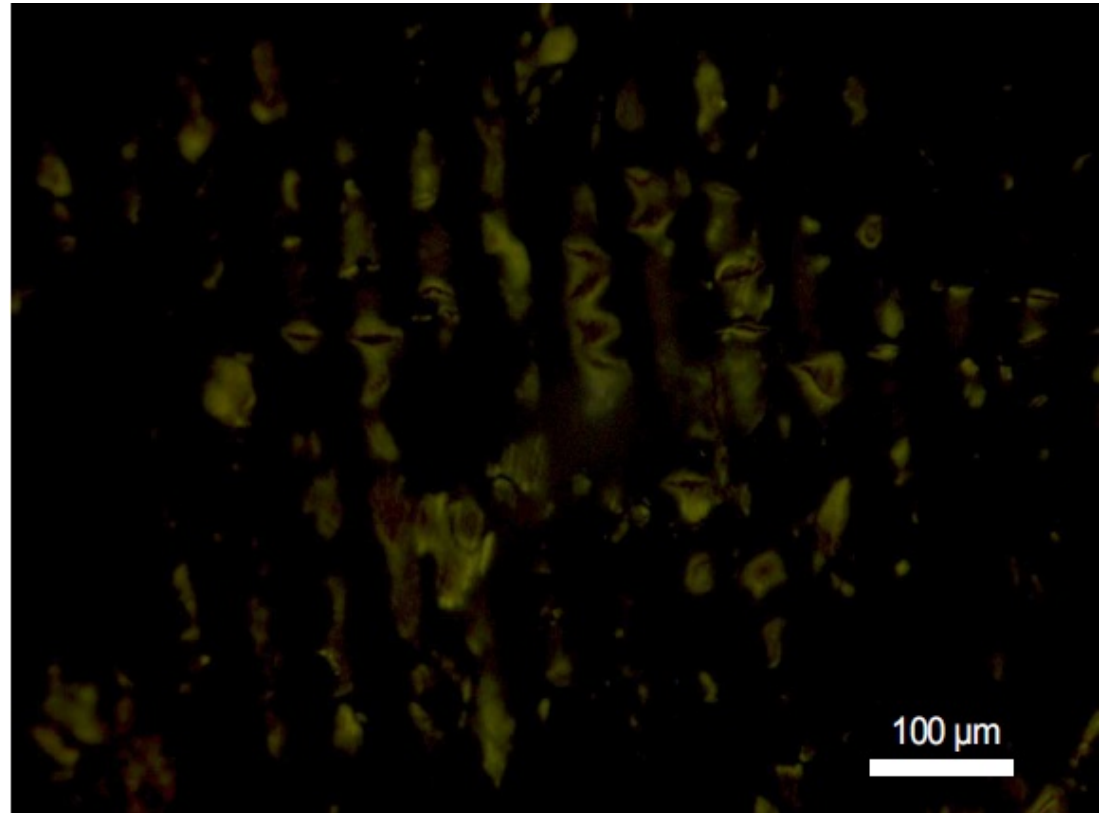
- Optical parameters modulated with interference patterns of light
- Azo-dye molecules undergo photoinduced reorientation, which turns also LC molecules  
→ Phase grating





# Experiments

Dark areas  
homeotropic,  
brighter isotropic



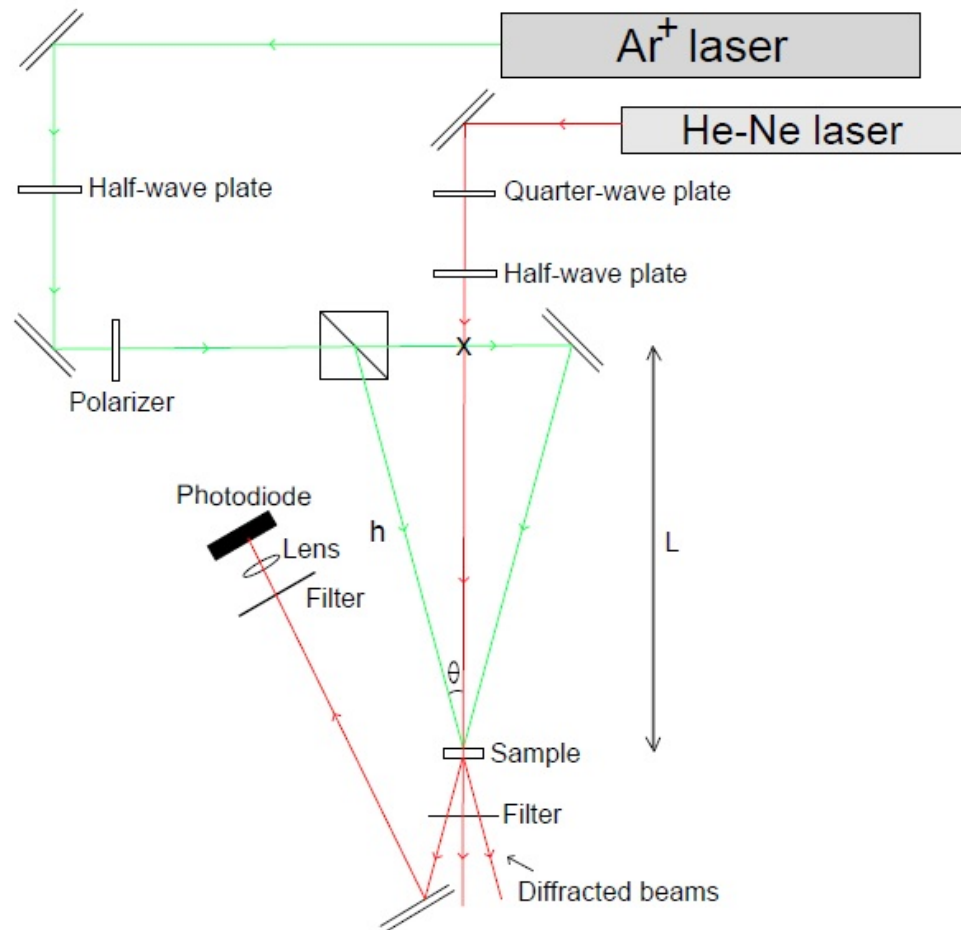
# Experiments

## HRG setup

Diffraction

efficiency defined as

$$\eta = \frac{I_d}{I_0} = \frac{P_d}{P_0}$$

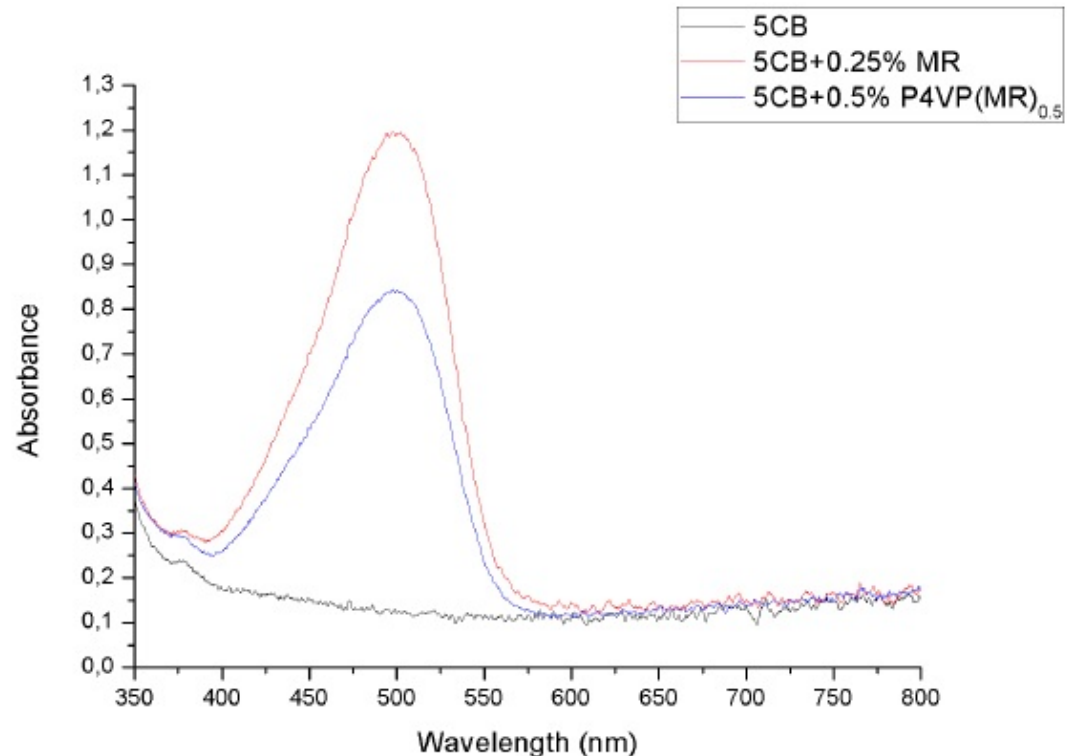


# Results

## Absorbance A

$$A = \ln \frac{I_0}{I_t}$$

- Maximum at 500 nm
- Addition of the polymer broadens the absorbance

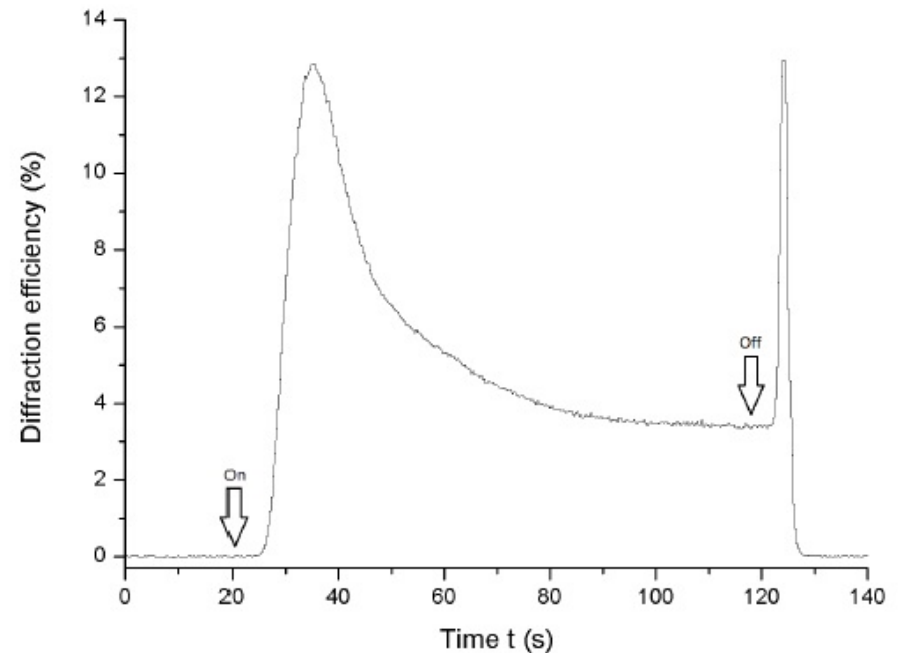




# Results

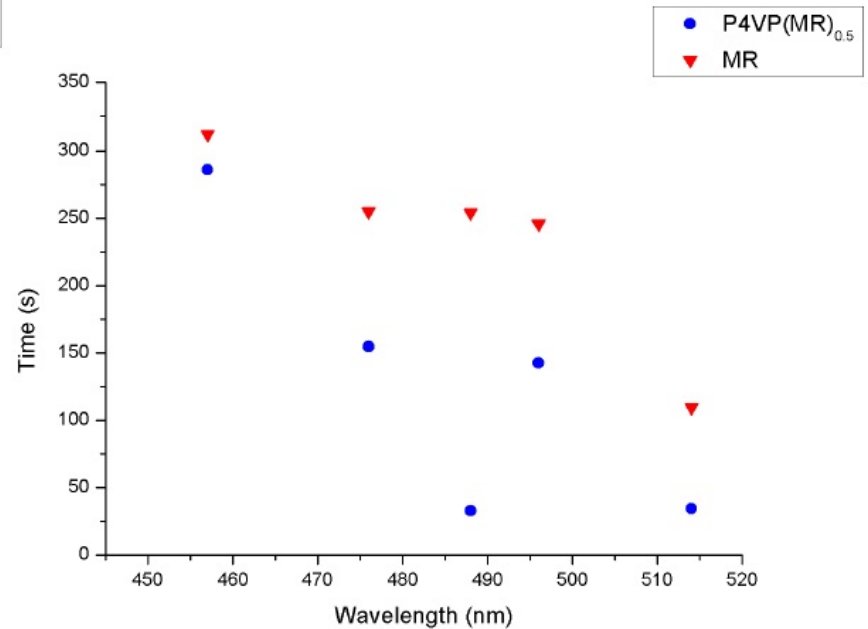
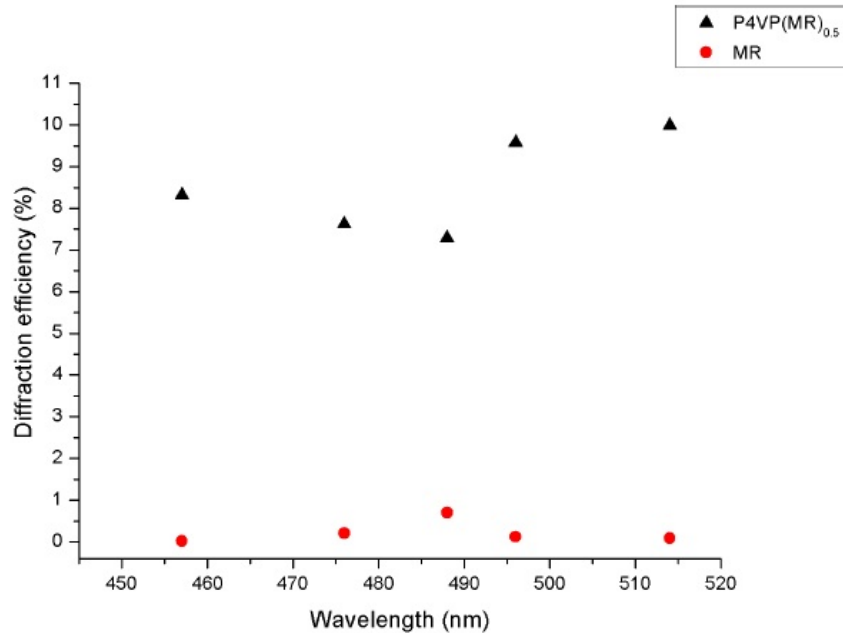
## Holography grating recording (HRG)

- First-order diffraction efficiency as a function of time
- Maximum efficiency and rise time considered



# Results

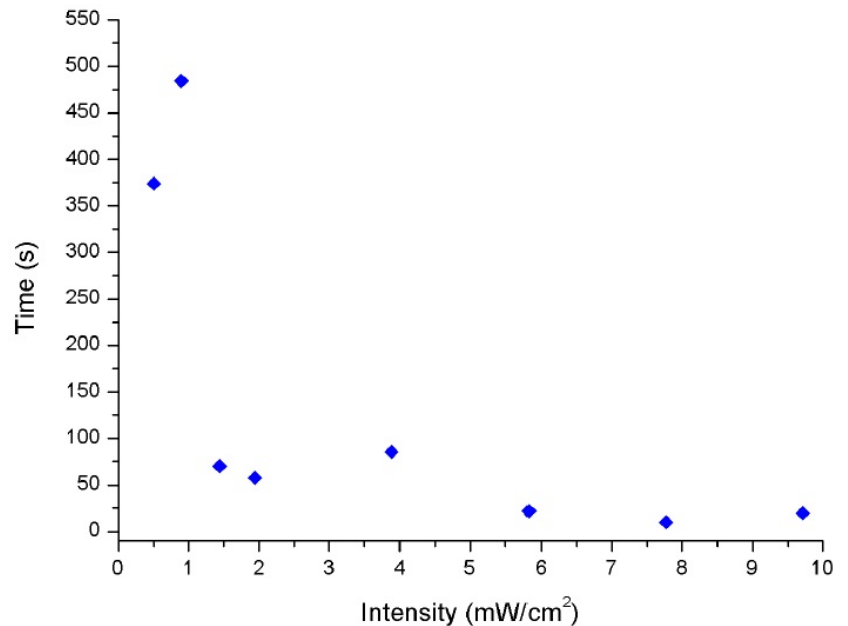
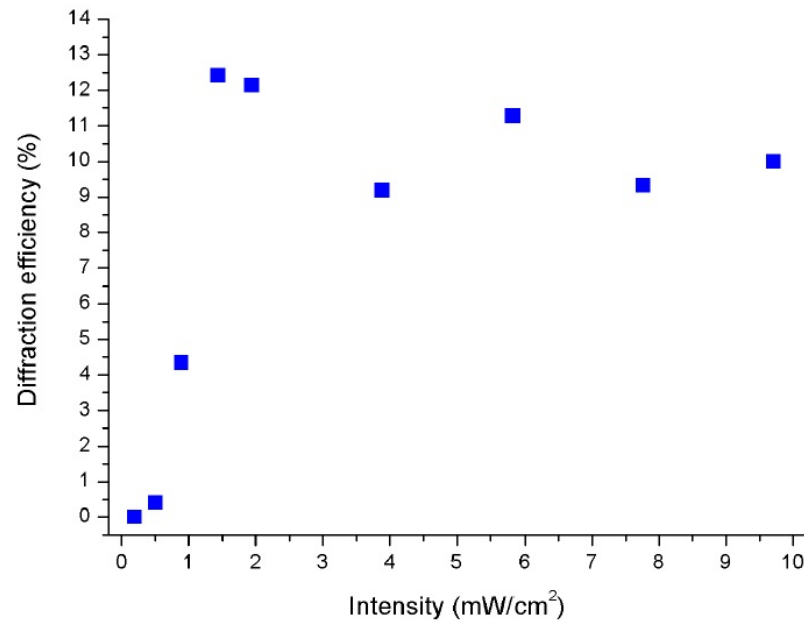
## HRG: The effect of wavelength





# Results

## HRG: The effect of pump beam intensity

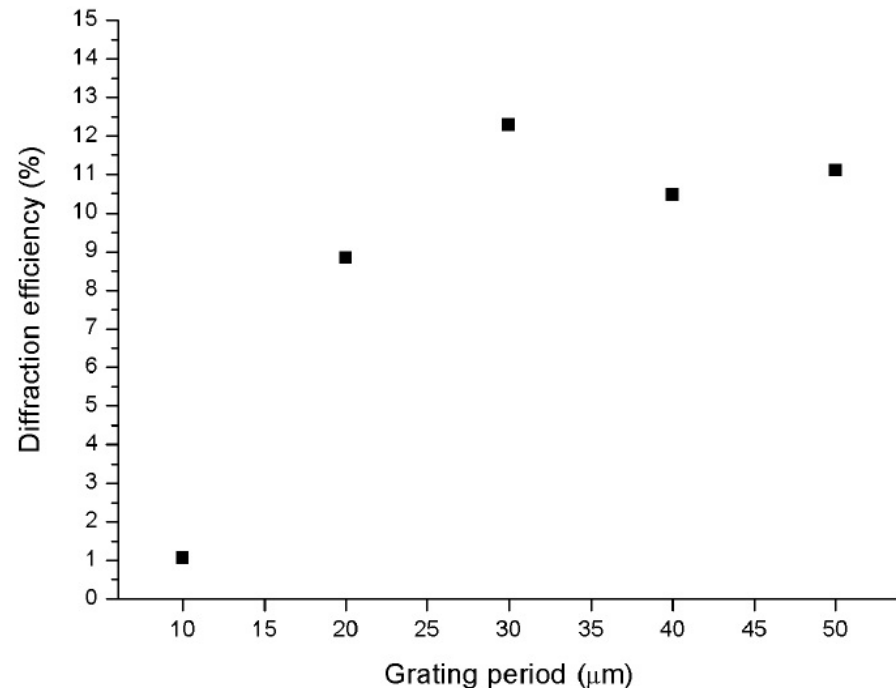




# Results

## HRG: The effect of grating period

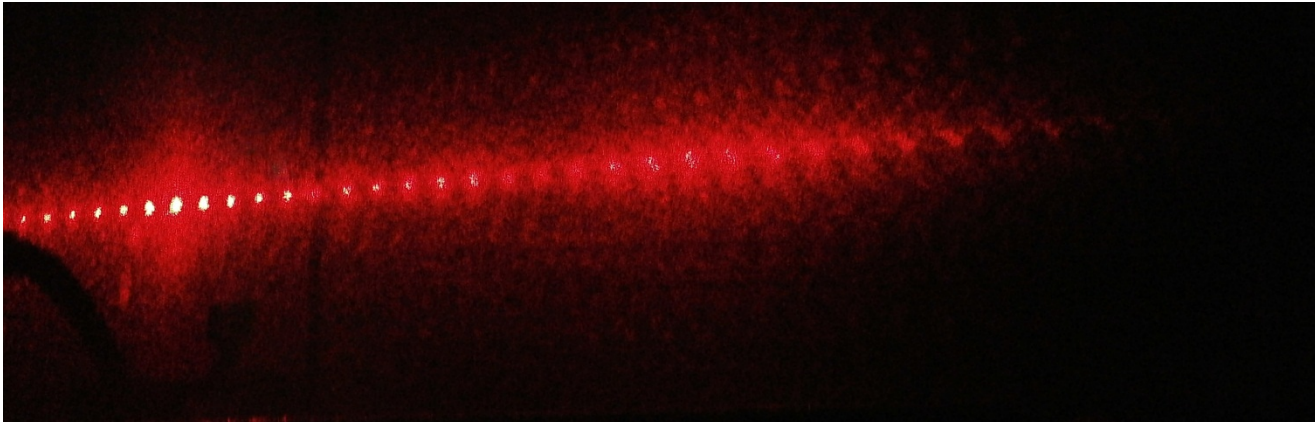
- Grating period does not affect the rise time



# Conclusions and future interests

## Conclusions

- Adding the polymer complex alters the optical response significantly
  - Mechanism for the formation of the diffraction grating
  - Enhanced diffraction efficiency



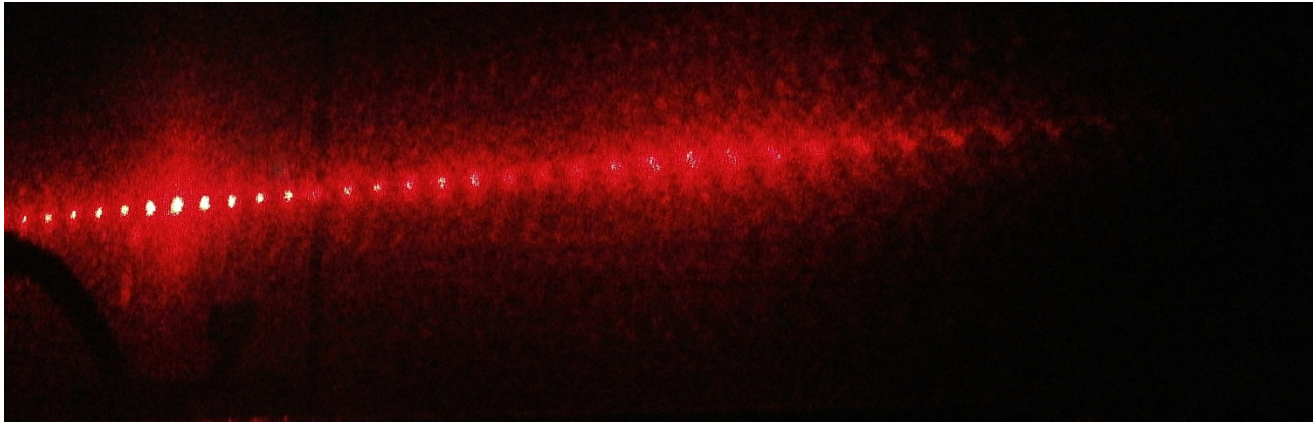




# Conclusions and future interests

## Future interests

- Further studies on effect of the hydrogen bonding
- Response to circularly polarized light
- Photocontrollable materials in e.g. medicine



# References

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