

Sudan University of Science and Technology

College of graduate studies

**Design and implementation of tunable
copper vapor laser and its application in
degradation of phenol in water**

تصميم وتنفيذ منظومة ليزر بخار النحاس متعدد الاطوال

الموجية واستخدامه في تكسير الفينول في الماء

A thesis submitted to the college of graduate studies
for the requirements of philosophy degree in laser physics

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Abstract

This work was devoted to design and construct a tunable copper vapor laser system and to select a single wavelength each time, using a volume holographic diffraction grating.

Also the work aim to the study of the effect of the discharge current and pressure inside the laser cavity on the laser lines intensity.

The tuning was accomplished by the rotation of the grating thus changing the angle of incidence of the laser on the grating and so the amplification exclusively had done for specific wavelength according to Bragg law.

The results showed that different laser wavelengths were recorded and tuned like 726.47, 665.04, 603.60, 588.07, 558.59, 516.14, 481.61 and 447.84nm, one wavelength each time. To use the constructed Copper laser, the green and violet lines (516.14, 481.61 nm respectively) were used to study the photo-reduction of phenol in water. The photocatalysis used here to provide electron-hole pair to attack the phenol molecules. The activity of semiconductors (ZnO and Al₂O₃) catalyst for photo-degradation of phenol has been investigated, the dependence of phenol degradation on laser irradiation time, catalyst concentration was also investigated.

Phenol degradation was achieved and it was affected positively by exposure time, amount of the catalyst and negatively by the laser wavelength.

المستخلص

استهدف هذا العمل تصميم وبناء منظومة ليزر بخار النحاس متعدد الأطوال الموجية (تتأغمي) واختيار طول موجي واحد في كل مره باستخدام محزوز الحيود الهلوجرافي الحجمي. كما استهدف البحث أيضا دراسة اثر تيار التفريغ الكهربى داخل مرنان الليزر على شدة الخطوط الليزرية.

تم الحصول على التتغيم المطلوب بواسطه تدوير المحزوز وبالتالي تغيير زاوية سقوط شعاع الليزر على المحزوز مما يجعل عملية التتضخيم الضوئى تتم حصريا لطول موجي معين حسب قانون براغ.

أوضحت النتائج ان اطوال موجية عديدة أمكن الحصول عليها وتم تتغيمها مثل: 726.4، 665.04 ، 603.60 ، 588.0 ، 516.14، 558.59 ، 481.61 و 447.84. حيث تم تسجيل طول موجي واحد في كل مره.

لغرض إستخدام ليزر بخار النحاس الذى تم بناؤه فان الطولين الموجيين الاخضر (516.14nm) و الطول الموجي البنفسجى (481.61nm) تم إختيارهما لدراسة عملية التفسير الضوئى للفينول. واستخدمت المحفزات الضوئية هنا للحصول على الزوج الكترون - فجوة لمهاجمه جزيئات الفينول.

درست فعالية اشباه الموصلات (ZnO ، Al_2O_3) كمحفزات للتفاعل في عملية التفسير الضوئى للفينول. كما درس أيضا تأثير زمن التعريض لشعاع الليزر وتركيز شبه الموصل المحفز على عملية تفسير الفينول.

تمت عملية تفسير الفينول بنجاح ووجد انها تتأثر ايجابيا بزمن التعريض وكميه المحفز الضوئى وسلبيا بالطول الموجي لليزر المستخدم .