INVESTIGATION OF IMPURITIES IN LASER MEDIA: CATHODOLUMINESCENCE AND FILAMENT INDUCED LUMINESCENCE COMPARISON

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Luminescence is the light emitting process when an electron jumps from excited to a ground state. In order to observe this phenomena within undoped laser host material a very strong electromagnetic field is required. Such intensities can only be reached during such experiments as cathodoluminescence, X-ray luminescence, nonlinear photoluminescence, etc.

In this work we are using filaments of light in order to induce luminescence and observe the resulting spectrum. This method is more convenient compared to cathodoluminescence or X-ray luminescence because the specimen is excited by laser beam. Besides, it allows to study decay of excited states which is not possible during other experiments. In this way, we have system which is easily adjustable and requires no complex optical elements. Use of filaments in luminescence spectroscopy is a nondestructive way to examine transparent solid material in order to determine it's quality.

By focusing femtosecond laser pulses in transparent medium, wide spectrum coherent radiation - white light continuum can be generated. When light self-action occurs, laser beam can shrink to micro-meter size and pulse spectrum can spread over several octaves. Within the generated filament there is enough electromagnetic field to excite impurities and charge carriers. Filament induced luminescence is observed and registered from the side of the filament. The main purpose of this work is to compare two different methods:: filament induced luminescence and cathodoliuminescence. Therefore, spectra were registered in different popular laser media such as YAG, Al_2O_3 and KGW. Specimens were provided by different manufacturers.

Overall,it was shown that characterizing lines of impurities are repeated in both experiments. For instance, Fig. 1 reveals that same ions of impurities were found in YAG crystals. On the other hand, it can be seen that the characteristic peaks differ in intensity, depending on the type of the excitation. Generation of optical filament is more suitable way to investigate luminescence in samples which have intense luminescence. When intensity is low it is better to use cathodoluminescence experiment because light is collected from larger area of the sample's surface.

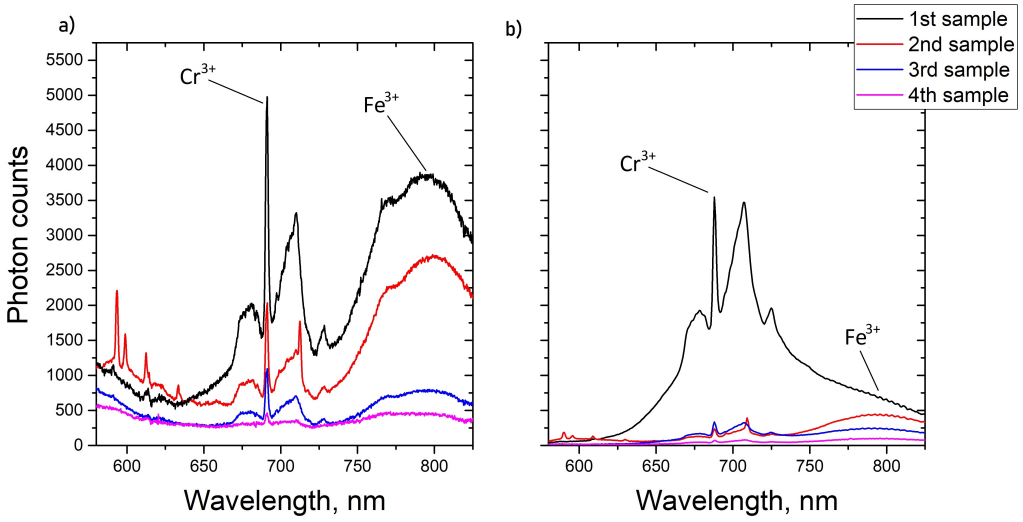

Fig. 1. Filament induced luminescence (a) and cathodolimonescence (b) spectra in YAG samples.