ALMA MATER STUDIORUM • UNIVERSITÀ DI BOLOGNA
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To Prof. Dr. Maciej Kubicki

Dean of Faculty of Chemistry
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Reviewer's report on the PhD thesis by Ms. Fatemeh Safari, submitted to the Faculty of Chemistry, Adam Mickiewicz University in Poznań

I have read the thesis entitled "the story of resorcinol crystals and a new perspective for stabilizing high pressure polymorphs at ambient conditions" by Fatemeh Safari with great interest.

Resorcinol is a "popular" molecule in organic chemistry, a precursor in many processes, and amply used as antimicrobial agent for pharmacological and cosmetic applications. It has been used and studied by many and for a long time. One could hardly expect to be able to find something new to say about resorcinol. This thesis demonstrates quite the opposite. There it was a lot to learn by investigating in details the solid-state behavior of resorcinol. This thesis does actually demonstrate that chemistry is a "never ending story" and that discoveries are always possible when the perspectives (and the equipments) change. As a matter of fact, this thesis looks into a fairly neglected aspect of the chemistry of resorcinol, namely that of its crystal polymorphs and solvates as a function of pressure.

The investigation of crystal polymorphism has become one of the strongest motivations for investigating known systems from new perspectives. This is because, as very well pointed out in the thesis, the existence for a given molecule of more than one crystal form, each one with its own physico-chemical properties, may have enormous consequences on the utilization, distribution, and marketing of the active principle. With this awareness many "old" molecules are being reinvestigated and new facts are being discovered. Resorcinol was known in two polymorphic modifications from data measured almost a century ago. Other contradictory information on resorcinol solid forms was available, making the whole story of resorcinol crystal forms quite intriguing and worth a reassessment. This thesis however is not only addressing in a systematic and thorough way the problem of resorcinol polymorphs. This thesis makes a significant step forward because it tackles

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the resorcinol polymorphism issue also by investigating the effect of pressure. This is not an easy job as X-ray diffraction measurements under pressure are certainly not routine experiments. It requires skill and patience. I was very impressed, on reading the thesis, that Fatemeh Safari could successfully use methods of high-pressure for in situ isothermal and isochoric recrystallizations within the diamond anvil cell and obtain a complete temperature/pressure phase diagram for resorcinol crystals. The work, published in Crystal Growth and Design, offers a clear picture of the structural reasons for the stability of the form alpha below 0.5GPa and of the form beta above this pressure.

The most remarkable results, at least in the opinion of this reviewer, are however those obtained in finding ways to stabilize high pressure phases, crystalline phases that cannot resist otherwise at ambient conditions. This stabilization has been achieved by formation of hydrates and/or by doping high pressure polymorphs of resorcinol with tartaric acid. These results were also the subjects of relevant publications in Crystal Growth and Design and J. Phys. Chem. C. Besides, these papers present the invaluable information about the phase diagram of resorcinol, with consistently located phases α, β and ε, as well as the newly discovered by Fatemeh Safari phase ζ. The full structural information about the thermodynamic parameters of these phases, their volume, thermal expansion and compressibility, as well as the networks of hydrogen bonding and molecular conformations, provide the general landscape of the polymorphic forms of resorcinol crystals.

The contribution of the coauthors as declared and are fully consistent with the work described.

In conclusion, the investigation of the phase behavior of crystals of resorcinol under high pressure has been conducted thoroughly and competently. Data are presented clearly, Figures are useful and tabular information concise. The student reveals good skill, imagination and a good writing style. Published papers are well written and hosted in relevant journals in the field. Altogether this thesis represents a significant piece of structural chemistry. Without any doubt, this thesis fulfills all requirements of the best PhD dissertations and I am fully convinced that Fatemeh Safari has demonstrated her qualifications as a PhD candidate.

I am happy to recommend this doctoral dissertation for distinction.

Best regards,