

<b>Title</b>	<b>Experimental study on polarized surface enhanced resonance Raman Scattering of rhodamine 6G adsorbed on porous Al<sub>2</sub>O<sub>3</sub> substrates</b>
<b>Authors</b>	K. D. Jernshøj, <sup>1</sup> S. Hassing, <sup>2,a)</sup> R. S. Hansen, <sup>2</sup> and P. Krohne-Nielsen <sup>2</sup>
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<b>Abstract</b>	<p>The polarization properties of surface enhanced resonance Raman scattering (SE(R)RS) of rhodamine 6G molecules, adsorbed to a hexagonally ordered gold nanostructure, are studied with the purpose to discriminate between adsorption sites with different plasmonic properties. The nano structure is based on a self-organizing hexagonally ordered porous Al<sub>2</sub>O<sub>3</sub> substrate sputter-coated with gold. Each hexagonal sub unit has D<sub>6h</sub> symmetry, where the symmetry center may act as an isotropic site, whereas the six narrow gaps between the individual Au hemispheres may act as hot-spots. The variation of the depolarization ratio (DPR), measured in resonance for the eight most prominent vibrational modes of the xanthene moiety, is analyzed by rotating the sample. According to theory, the DPR of the SE(R)RS signal obtained from molecules physisorbed in the isotropic sites deviates from the DPR originating from molecules physisorbed in the hot-spots in two ways: 1. The DPR associated with the isotropic sites depends differently on the rotation angle than the DPR associated with the hot-spots. 2. The DPR of the SE(R)RS signal obtained from molecules physisorbed in the isotropic sites depends on the nature of the Raman modes, whereas it for molecules physisorbed in the hot-spots is independent of the nature of the Raman modes. By applying the latter in the analysis of the polarized SE(R)RS data, we conclude that the dominating SE(R)RS signal comes from molecules adsorbed in the hotspots. However, since the DPR's obtained for Raman modes of different symmetry are slightly different, the SE(R)RS signal must contain an additional contribution. Our analysis shows that the small mode-dependent SE(R)RS signal most likely comes from molecules adsorbed in the isotropic sites. The general result that can be derived from the present study is that by measuring the polarization properties in SE(R)RS and SERS it is possible to discriminate between adsorption sites with different plasmonic properties present in a highly symmetric nanostructure, even when the magnitude of the different contributions are highly different. The consequence of the insufficient spatial resolution with respect to a detailed mapping of the substrate often encountered in unpolarized SE(R)RS and in two-photon luminescence microscopy may thereby be circumvented.</p>
<b>Laser Quantum Product</b>	Ventus 532
<b>Institute</b>	<p><sup>1</sup>Faculty of Science, Department of Biochemistry and Molecular Biology, Celcom, University of Southern Denmark, Campusvej 55, DK-5230 Odense M, Denmark.</p> <p><sup>2</sup>Faculty of Engineering, Institute of Technology and Innovation, University of Southern Denmark,</p>