First hyperpolarizability ($\beta$) of bare and polymer protected copper nanoparticles PUSPENDU DAS, MANABENDRA CHANDRA, Indian Institute of Science — We have prepared bare as well as polyvinyl pyrrolidone (PVP) capped Cu nanoparticles (NPs) of <10 nm size by laser ablation and measured their first hyperpolarizabilities ($\beta$ values) using the hyper-Rayleigh scattering technique in solution. The $\beta$ values for the bare and capped NPs are $414 \pm 19 \times 10^{-30}$ and $808 \pm 12 \times 10^{-30}$ esu/atom$^{1/2}$, respectively. The bare NPs are stable in isopropanol for weeks but are short-lived compared to the capped particles. Our results of capped NPs having a $\beta$ value twice as high compared to the bare NPs of the same size show that surface capping is necessary for enhancing $\beta$ in noble metal NPs. In addition to the bulk and surface quadrupolar contributions which exist in bare NPs, dipolar contribution to $\beta$ becomes important for the capped NPs due to the destruction of centro-symmetry at the surface, leading to a significant increment in $\beta$. Experiments with smaller size NPs show that $\beta$ goes down with size. The bulk quadrupolar polarization which decreases with particle size, perhaps, rationalizes the size dependence of $\beta$. 

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